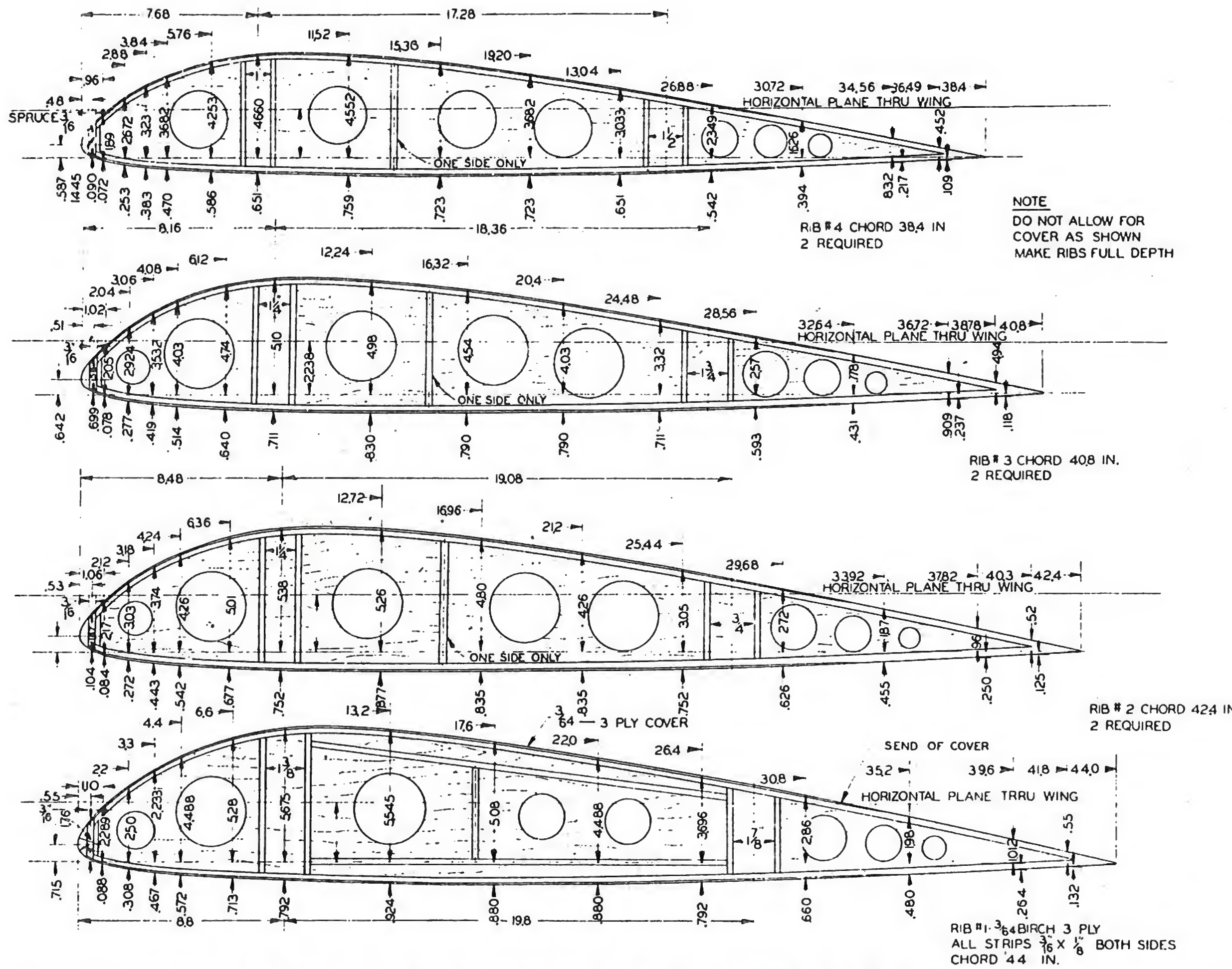
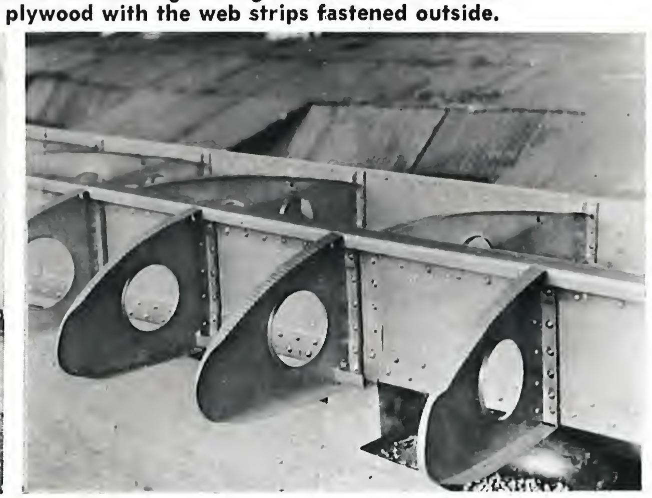


Above you will see the template measurements for the larger wing ribs in near the base of the wing. These are likewise made up of plywood with the web strips fastened outside.



Front and rear views of slots and flaps that were installed on Army Air Corps Dart.

High aspect ratio metal cantilever wing under construction by Air Corps Material Division.

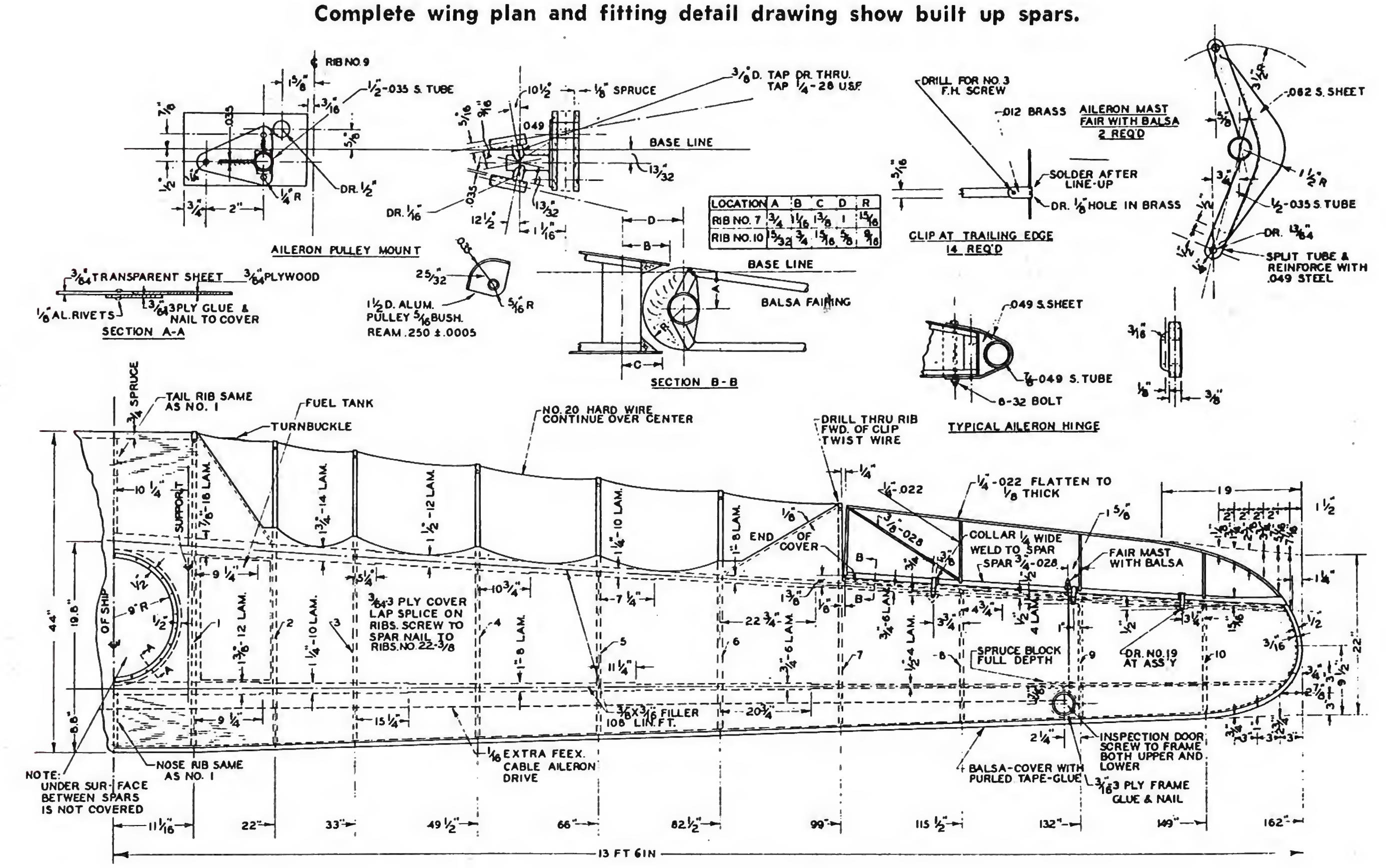
necessary. From your local mill obtain some planks 1/8 in. by 7 in. by 12 ft., and some 1/8 by 4 by 1/2 from clear spruce. This material need not be especially the airplane quality, but should be free from knots and reasonably straight grained. Then obtain two 6 in. by 8 in. by 14 ft. beams and two planks 2 by 8 by 14 ft. for use as cauls. Spike these beams end to end onto about six saw horses. Be sure that they are perfectly level and without any twist. They should be perfectly straight. By referring to the wing drawings we see that the different laminations of the spars stop at different intervals from the center. Lay off these intervals on the beam and cut the outside lamination from the front spar, laying one of these pieces on the beams and securing it with a few small brads. Place two separate pieces outboard of this center lamination the remainder of the length of the beam. Also brad these pieces down.

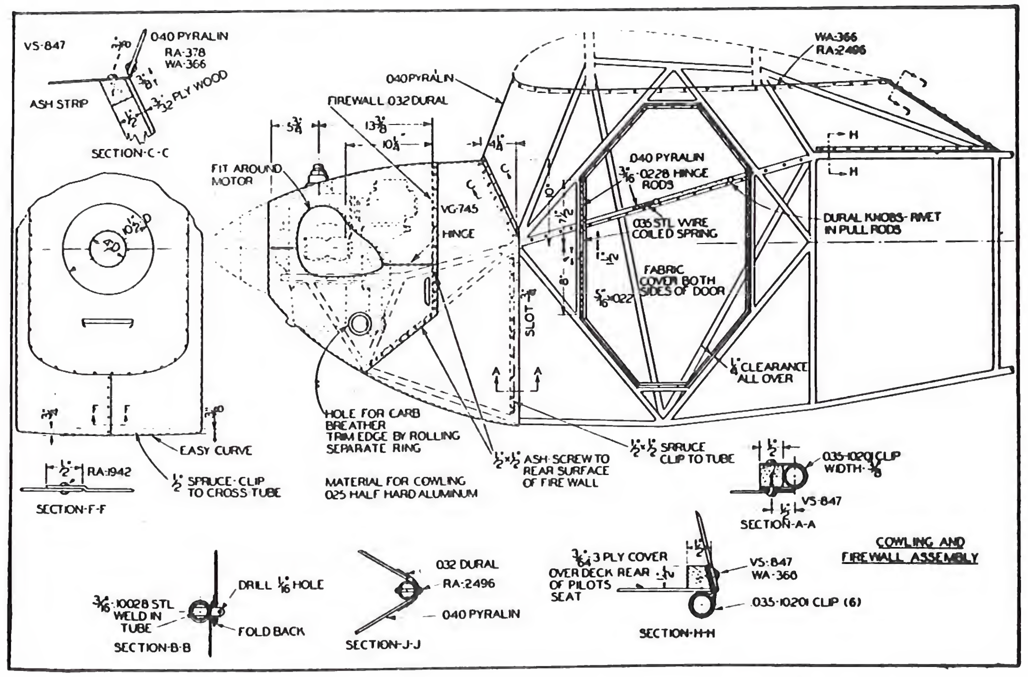
Cut the next lamination and lay it on the first, using shorter filler pieces at the end. Continue until all of the spars laminations are cut. You will note that the center four laminations are continuous and that your material is not long enough to reach. Each lamination may be spliced taking care that no two pieces have a splice closer together than about two feet. A good scarf splice should be made using a slope of about 1 in. for the 1/8 in. plank. When the laminations have all been cut and spliced they should be glued together by applying the glue to the shorter planks of any pair. That is, apply the glue to the first plank and lay down the next. Apply to the third and so on. Fill the ends on top with 1/8 planking cut-offs and firmly clamp on the two 2 in. planks above mentioned. Use about four dozen 12 in. C-clamps. Allow the spar to dry about 24 hours before removing from the caul. Be sure to use casein glue only. When the clamps are removed you have your front spar ready to work down.

The rear spar is made from the four inch planks in a similar manner except that the beams are raised up at the tips to take care of the bend in this spar as shown. This is accomplished by blocking up each successive saw horse until the beams make the proper included angle. Then a piece of soft wood should be screwed to both planks in the center and worked down by hand to form the proper radius for the bend of the spars. After the caul is thus made proceed exactly as for the front spar.

After the spars are made and dried the next step is to lay out a center line on the spars and then lay out the heights of the spar at each rib point from the rib drawings. When this is done the spars may be sawed approximately to these points and worked down by hand so that the ribs will slip in place. These lines marked, horizontal plane on all ribs should be marked on the spars, especially on the rear since it is the same as the center line on the front. On the rear spar this line is somewhat above the center but is perfectly straight.

Complete wing plan and fitting detail drawing show built up spars.



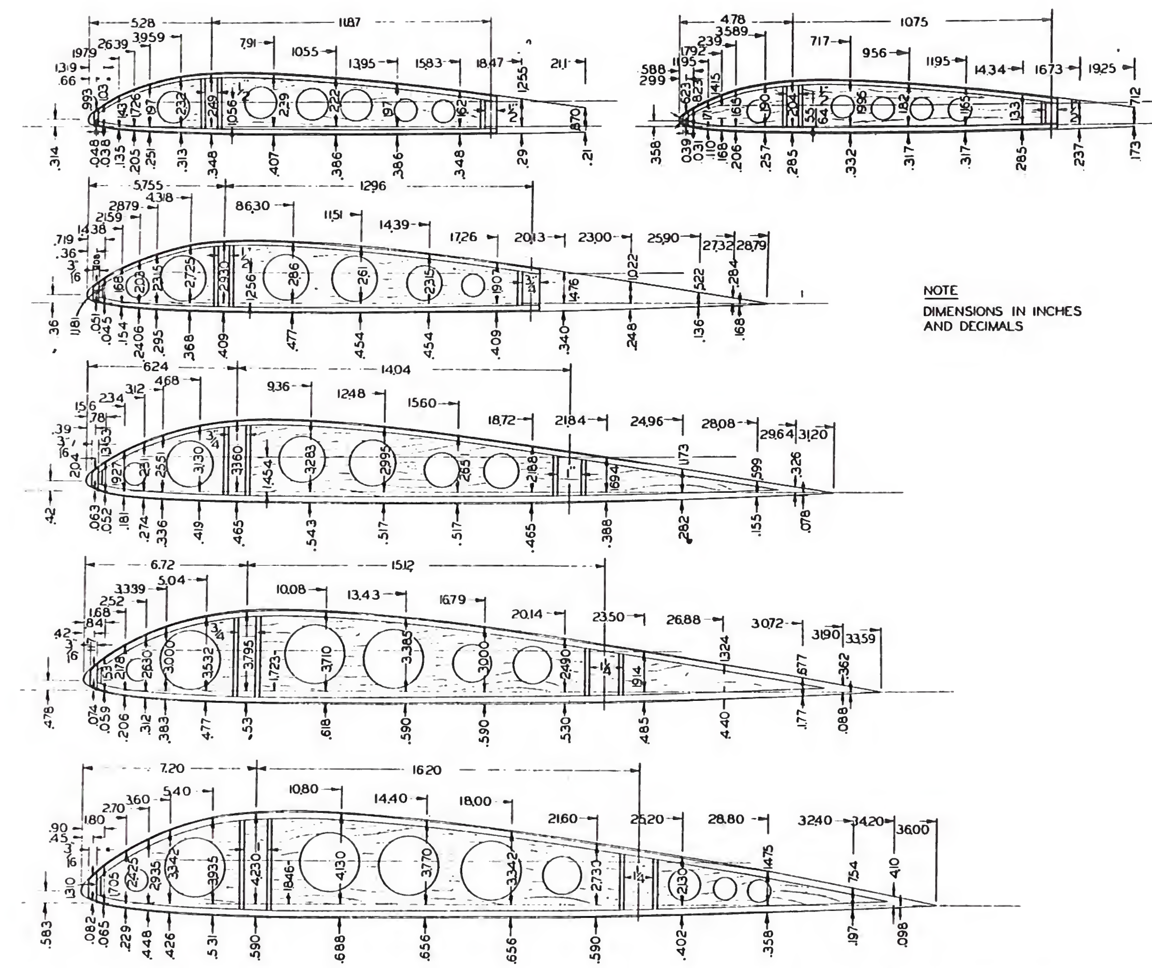


Here are more intimate details of the forepart of the fuselage to supplement the fuselage plan given in the first installment. Note the general shape of the cowling and the method of fitting the door.

When the ribs have been properly fitted the whole assembly should be clamped to the saw horses in an inverted position and blocked at various points to insure that the two lines on the front and rear spars are perfectly level. Then glue and brad the ribs to the spars in the proper locations. Glue a strip of spruce 3/16 by 3/8 between each rib along the center line of the spar at top and bottom so that the cover will have an attachment to the spars. Shape the leading edges of all ribs to a straight edge and apply the spruce leading edge piece, gluing and nailing to each rib. Then apply the plywood cover to the bottom surface, gluing and nailing to each rib. It is well to cut each panel before applying and to work from the tips inward. Make all splices in the cover at the ribs by lapping about 3/8 in. When the lower surface has been applied and the glue has had an opportunity to dry turn the wing over and apply two coats of good spar varnish to the inside, except to the tops of the spar strips and the ribs. Again block up the wing so that the base lines are level and apply the top cover. Make sure the blocks and the aileron hinges and aileron pulley brackets are glued in before the cover is applied. When the wing is thoroughly dry apply the balsa leading edge and form the contour by hand. Sand the wing and cover the trailing edge with cloth on which apply four coats of dope. The cloth is tacked to the rear spar and the joint covered with rib tape. Glue rib tape over the leading edge balsa and apply two coats of spar varnish over the whole wing.

Before the wing is sealed up the fuel tanks must be built and installed. Any good tinner can make up this tank when the filler caps, etc., have been machined up for him. No description of the

Air Corps Driggs Dart with a Wright-Morehouse engine. Aircraft weighed 400 lbs. empty and had a useful load of 239 lbs.



The wing ribs are made of 3/64 in. plywood. Two are made from each of these dimensioned drawings, thus assuring identical cross sections of both wings. Cap strip run on each side, in profile.

WINGS AND FUSELAGE FOR THE DRIGGS DART

In the first section of this article full details for the fuselage parts and the method by which this most important part of the ship is constructed were treated. Herewith, in this, the second part of the Driggs Dart design story, details on the wings and further data on the fuel system will be added to make the story more complete. When you have completed the balance of the story given here you will have the complete design, just as I turned it over to the Army Air Corps for acceptance, only minus the voluminous stress analysis.

Here is the data on the construction of the wing:

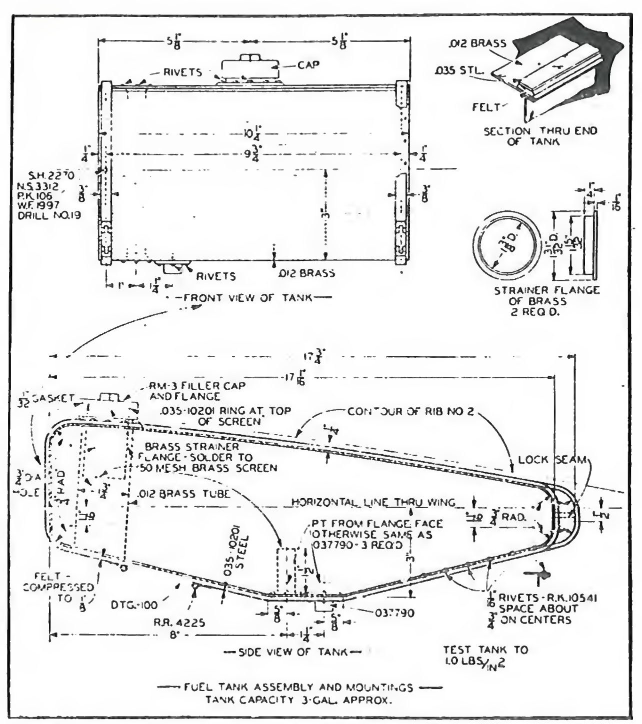
By referring to the drawing on page 37 we see that the wing of the Driggs Dart is full cantilever, that is, without external bracing, and is plywood covered. Sufficient plywood 3/64 in. thick should be ordered to cover the wing as shown and to make the 21 ribs. Then obtain about 84 pieces of spruce 3/16 square and about four feet long for the rib cap strips. These ribs are made of one sheet of 3/64 plywood with the cap strip nailed and glued in each side. They may be laid out on one piece of plywood and that tacked to another and then both bandsawed together. This will insure that the corresponding ribs on each side are alike. With the rib contours sawed from the plywood each size is lightly tacked down on a smooth plank and about a dozen 1/2 by 1/2 by 1 in. blocks are nailed to the plank around the outer edge of the plywood, as closely to it as it is possible. After the blocks are nailed to the plank so as to form the rib jig the 3/16 square pieces are glued and nailed to the plywood. Use the best grade of casein glue. Force the cap strip out against the blocks with the fingers to insure that the proper contour is obtained. It will be necessary to soak the strips for the deeper ribs at the nose in hot water to make the bends without breaking the strips. When the strips are applied to one side of the plywood pry off the plank and apply the strips to the other side by constructing a similar jig, but of opposite hand. When the ribs are dry they should be cut out for the spars with a sharp knife and neatly trimmed and sanded. Do not varnish at this stage.

The next problem is to make the spars. This is where the services of a good cabinet maker will be

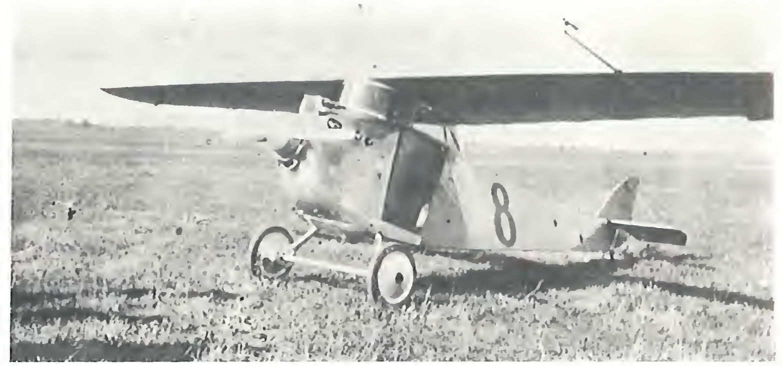
should be made to insure that all parts are properly located, especially the wing attachment fittings and the motor mount. When you are sure that everything is O.K., complete the welding at each joint as far as possible so as to insure that the members will not shift after removing from the jig. The splices in the rear longeron should not be welded until the last operation. When this is complete remove from the jig by sawing off the cross members. Place on horses and complete the welds at every joint. Next wire up and line up the rear part of the fuselage, using small buckles and the wire called for.

The next operation is to varnish the fuselage and to cover it. After varnishing, bolt in the spruce stick at station three, and wrap the members around the door with tape to which you can sew the cover. When covered dope with three coats of good nitrate dope and paint.

The next part to make is the landing gear. The average man has a great amount of trouble in building a gear so it is true. The whole secret is in having a good jig, and the best one is the fuselage that has been completed. Support the fuselage on two horses so that the lower longeron at the gear attachment is about 12 in. from the floor. Level the fuselage fore and aft, and crosswise. Plumb down to the floor from the center of the front fuselage fitting and lay out the wheel centers on the floor. Support small pieces of axle tubes on blocks from the floor in the exact location given on the drawing. Set up the upper ends of the main axle and brace tube and bolt into fuselage fittings. By sawing at



Here are the complete details for the beautifully engineered design of the wing tank. All dimensions are given. It would be wisest for the amateur-builder to take this job to his local tinsmith, who will build it for him.



Highly streamlined Dart was ahead of its time. Engine was a 28 hp Henderson.

the proper angle the main axle and the stub for the wheel are made to meet properly where dimensioned. When the three tubes fit properly they should be tacked together and the fittings made up and applied. The welding on the axle should be completed as far as possible before removing from the fuselage and floor blocks. When completed each vee should be heat treated by a competent man to the specifications given. The S.A.E. number of the steel is 4130 which the heat treater will have to know. The shock tube is too simple to make to warrant any explanation. Next the tail surfaces and ailerons should be made. Obtain some 3/4 by 6 yellow pine lumber and make jig boards sufficiently large for each surface. On these boards lay out each surface and all of its members. Make up some blocks about 3 in. high, with holes in them on center, the sizes of the various spars and leading edges. Split these blocks and nail to layout boards at suitable intervals to support spars. Be sure they all line up perfectly level. Cut spar tubes and clamp in jig to the above blocks. Then bend up rib tubes and weld in where shown. Tack as far as possible in the jig and complete welding after removal. Thoroughly varnish, then cover and dope. Be sure that all hinges properly line up on adjacent surfaces before completion.

The tail skid, motor controls, seats, flooring and plane controls can now be made and installed. No jigs are necessary for these parts which can easily be made by a good welder and mechanic. No description of their construction will be given.

In the next part we will describe the making of the cowling, and the installation of the motor fuel system.

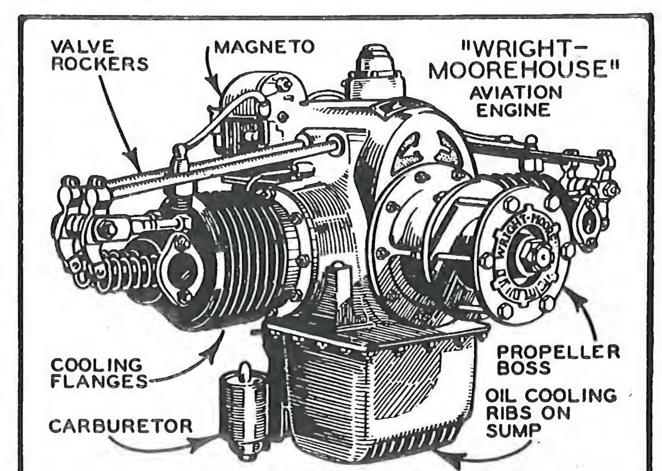
This ship has been flown in all kinds of weather, and has made long cross country hops successfully. It has a high speed, with a Henderson motor, of around 84 mph, and a ceiling of about 12,000 ft. It will climb better than 300 fpm and is very sturdy and rugged. The ship built for the Army to these specifications is shown in a photo on page 31. We have built another, powered with a Henderson, and it is from this ship these figures are taken. The ship shown above is powered with a Bristol Cherub and performed in every way like its bigger sisters. Full illustrations for building the wing will appear in the second part of this article.

With lift devices open Air Corps Dart could take off in 531 ft. and land at 42 mph.

method of making this tank is necessary since a person constructing this airplane would much better turn this job over to his local sheet metal shop.

Previously we have described the method of building all of the structural parts. Now we will describe the construction of the fuel system and of the cowling, together with a table of the source of supply of suitable material.

In installing the fuel system only ground union joints should be used, except between strainer and carburetor where we have shown a hose connection. Care must be taken so that the lines always have a downward slope so as to avoid any possibility of air pockets in the tubes. Bends should be very carefully made and not too sharp or the tubes will be considerably flattened and reduced in area at the bend. Thoroughly anneal all tubes with torch after bending and clean out all scale. The type of fuel level gauge shown is the most simple and reliable. Naturally one should be used for each tank. In making the union connections be sure to thoroughly sweat the ends of the tubing before trying to solder on the nipples. A line of solder around the tail of the nipple is not sufficient to hold the joint. If these instructions are carefully followed you should have no trouble with the fuel system.



This is the famous Wright Morehouse lightplane engine, now no longer manufactured by the Wright people of Paterson, N.J., which powered the original Driggs Army Dart.

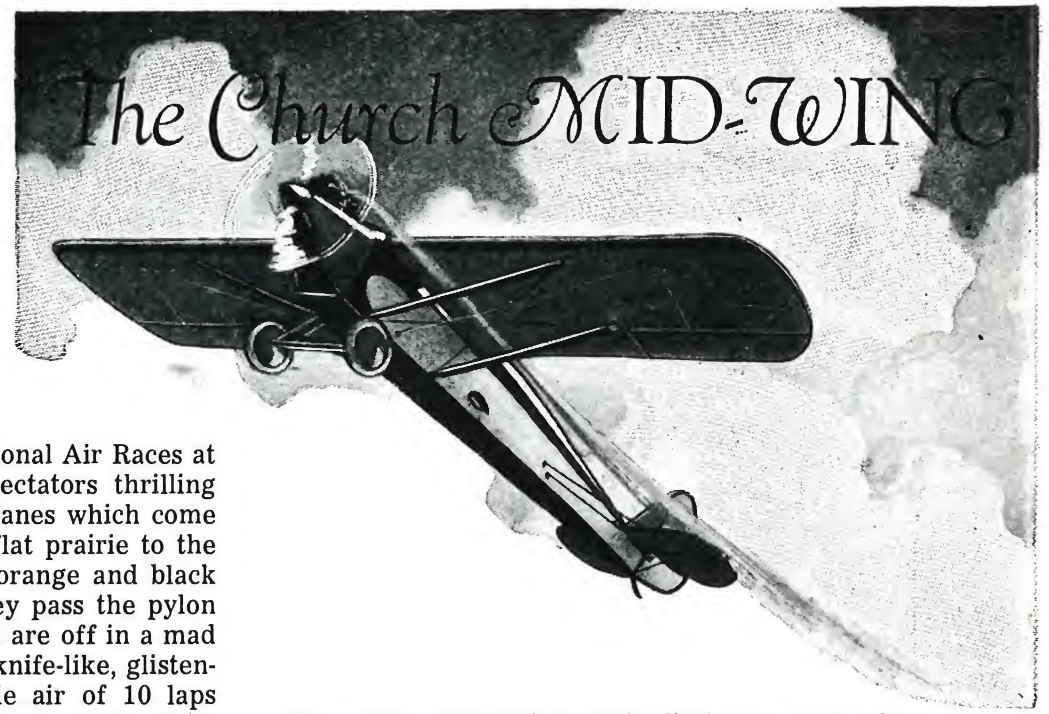
The good appearance of your ship depends upon the care with which the cowling is made. A person sometimes gets too anxious at this stage and slights the final finish. To properly make the cowl a form should be made to which the pieces are fitted while bumping. If this form is well made and the parts fitted to it carefully, you cannot help but get a good job. If the builder knows nothing about bumping or forming metal the services of an automobile body repair shop had best be enlisted. With a power hammer a much smoother job can be done and in less time.

The cowl sections should be laid out on 3/4x4 Yellow Pine boards and suitably held together by four longitudinal pieces notched into the section formers at the top and bottom and two sides. The angular section for the lower part of the firewall should also be set in. This form should be well screwed and glued together and properly braced so that it cannot be sprung out of shape when being worked upon.

You will note that the cowling is made in three parts, an upper and lower motor cowl and a fuselage cowl. By forming these pieces separately rather than the whole cowl in one piece will considerably simplify the work. The firewall is laid off the same way the cowl former bulkheads are made, and is screwed to ash bending around its outer circumference. These bendings serve to fasten the firewall and front fuselage cowl together.

We believe the drawings are sufficiently clear that this cowl can be made with but little trouble if the bumping form is properly made as above outlined.

The writer hopes that with these drawings and the above explanation any one with fair mechanical ability will be able to build the Dart I.



The Church MID-WING

At some sacrifice in vision, Jim Church, versatile engineer and lightplane fan, builds a mid-wing ship from a Standard Parasol which can easily do 90 mph.

Imagine ourselves at the National Air Races at Cleveland. There are 100,000 spectators thrilling at sight of a group of tiny lightplanes which come droning and whining across the flat prairie to the starting pylon — the checkered orange and black tower before the grandstand. They pass the pylon in a group, a race horse start, and are off in a mad dash that will not end until their knife-like, glistening wings have cleft the invisible air of 10 laps around that five-mile triangular course marked by three tall pylon towers, the farthest being invisible in the light ground haze.

A moment after the start the little planes are so far away that they can hardly be seen as they skim along like projectiles over the plain. An eager young man wants to know if that fast yellow-and-black one is the famous "Baby Bullet" and another excited fellow screams in his ear that the "Bullet" is not entered in this race, which is Event No. 2, for planes with 100 cu. in. piston displacement or less, and that fast one is the Church Mid-Wing Sport Monoplane which he hears is built from the Super Parasol fuselage and wings, together with a few conversion parts designed by James Church and can do better than 90! The attention of the mammoth crowd is taken again by the return of the racers completing their first lap. Here they come almost on the ground it seems—who's ahead? No. 40, the yellow-and-black, the Church Mid-Wing, is a long way ahead. Freddie Lund, magnificent pilot, holder of the world's outside loop record, who is flying her, dives at the pylon.

Vertically he banks around it with his wing tip almost dragging the ground and is off again in a twinkling. The other contestants hurl their planes around the pylon in dizzy succession, the backwash from each plane throwing up a regular explosion of dust from the ground at the foot of the pylon.

On and on through the golden sunlight of the September day dash these little man-birds, each guided by a high heart and a steady hand, each a manifestation of the wonders of physics and chemistry as yet imperfectly understood by man. The

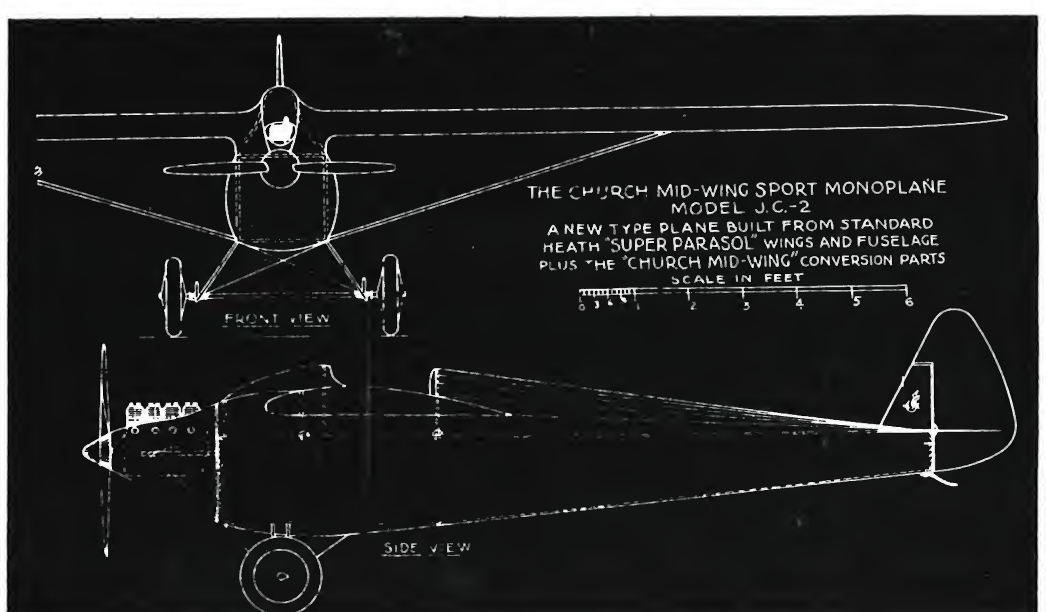
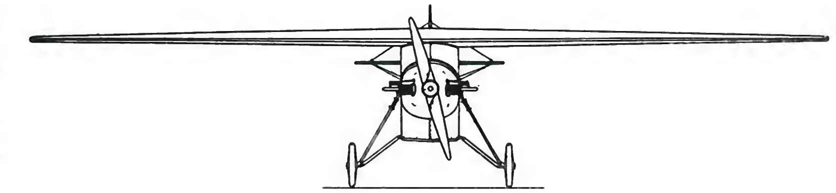


Fig. 1. This is the profile and front elevation drawing of the cleverly converted monoplane. It shows the somewhat flatter bracing, with the consequent reduction in cabane strut interference which partially accounts for the speed increase of about 20 to 30 mph.

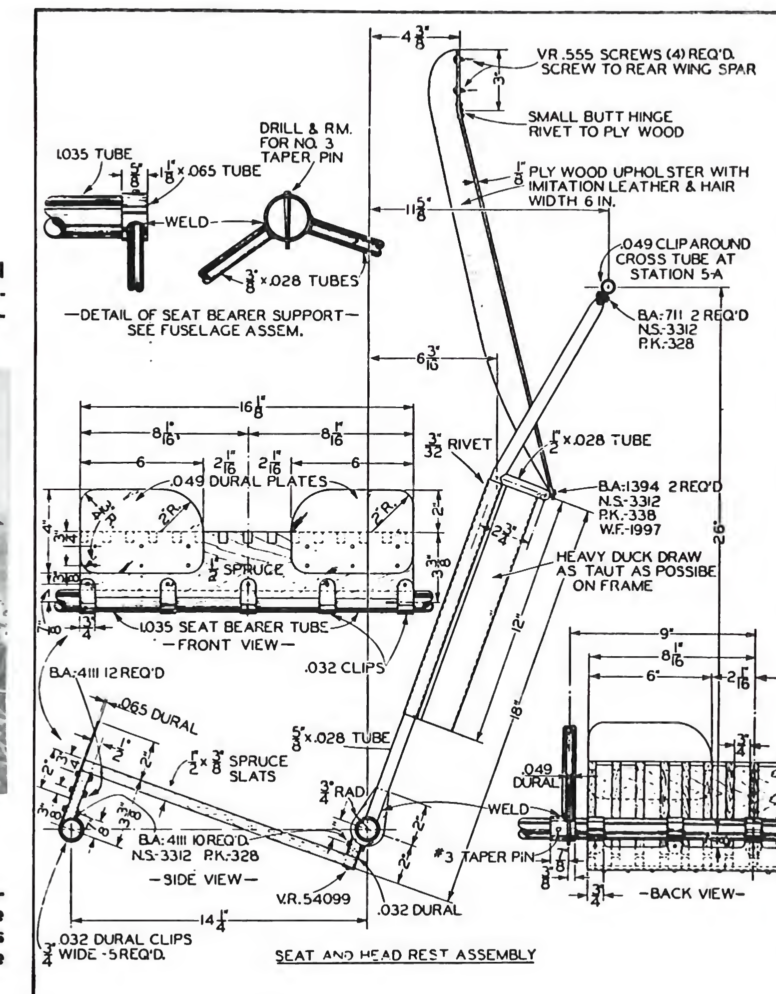
This view shows the enormously refined lines of the Dart I, with parasite pared to the "irreducible limit." The full cantilever wing is the modern thing, and is highly efficient and ruggedly strong.



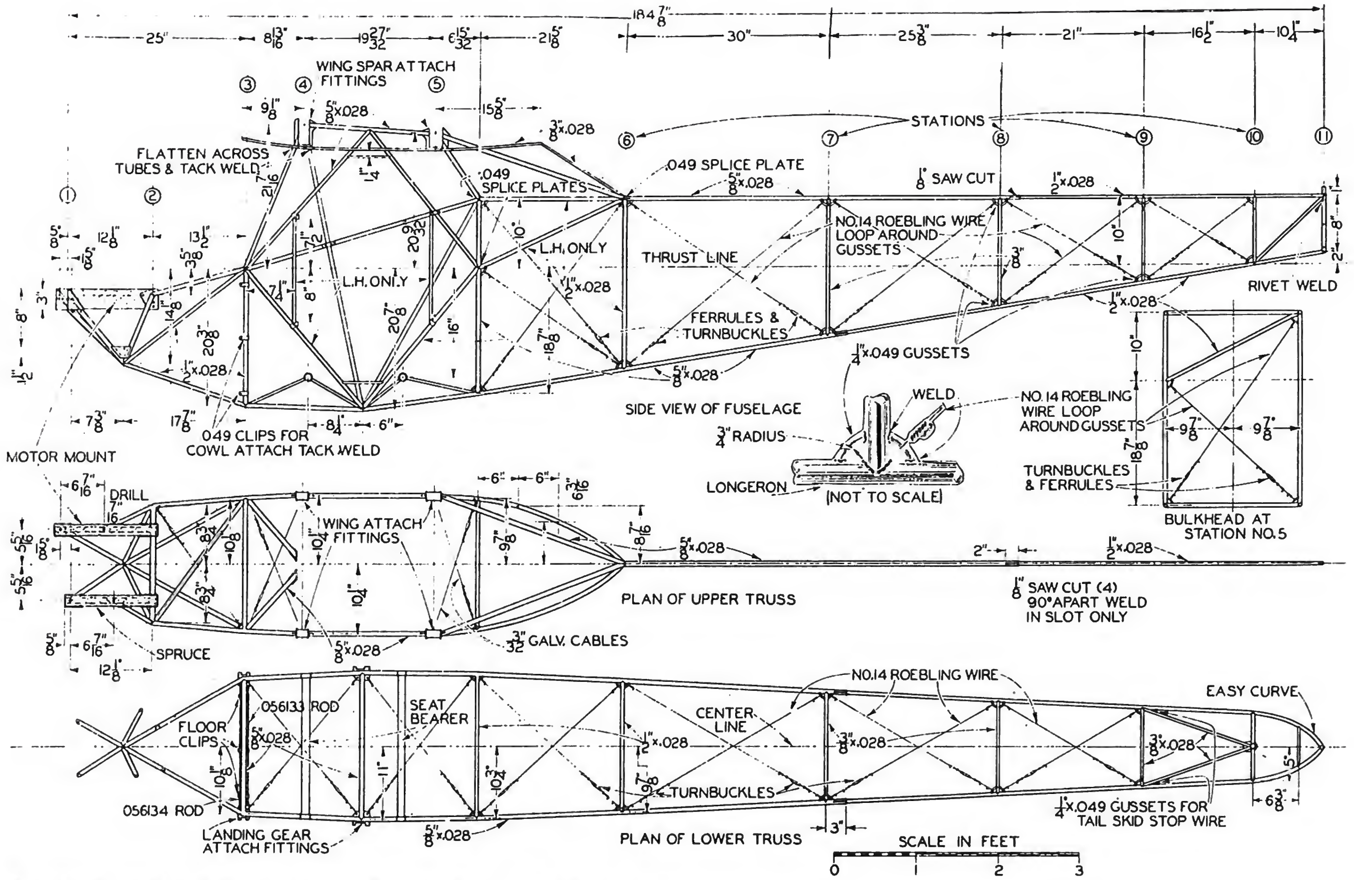
the center line of the longeron plus one-half the diameter of the cross tube as given and securely nail these cross members on the front of the uprights. Bottom cross members at every station should be placed below the longeron and tangent to its lower surface, top cross members above. For the attachment of motor mount and wing fittings make up dummy motor bearers and wing spars and support from cross pieces. Make up fittings and properly locate on these dummy members.

We now have a frame into which we can lay our tubing for welding. Referring to the plan view of the fuselage, lay out on the lower cross members the center line and both sides of the lower longeron clear back. Do the same for the single upper longeron. You are now in a position to cut and fit the tubes previous to welding. Obtain sufficient of the specified sizes. Specification 1025 will be satisfactory. First fit the upper longeron and fasten in place by a piece of wood with a hole in it the size of the longeron. This piece is nailed to front of top cross member in such a way that the longeron is held exactly on the lines previously laid out. Next fit in the two bottom longerons in a similar manner. When the longerons are in place and the work has been thoroughly checked, the uprights and cross members are next fitted. It is not necessary to file out the tubes to fit the longerons exactly in such small sizes. Simply cut them off square and allow about 1/32 clearance for expansion when heated. When these tubes have been all fitted, an experienced welder should tack them lightly into place. Next make up the corner gussets. These pieces can best be made by coiling the tubing around a large steel bar in a lathe, similar to the way a spring is coiled. After this coil is made it is sawed into four pieces lengthwise. Next the welder tacks in these gussets. Go over the fuselage and set in all fittings not already mentioned, having them lightly tacked into place. When all parts are in, a thorough check

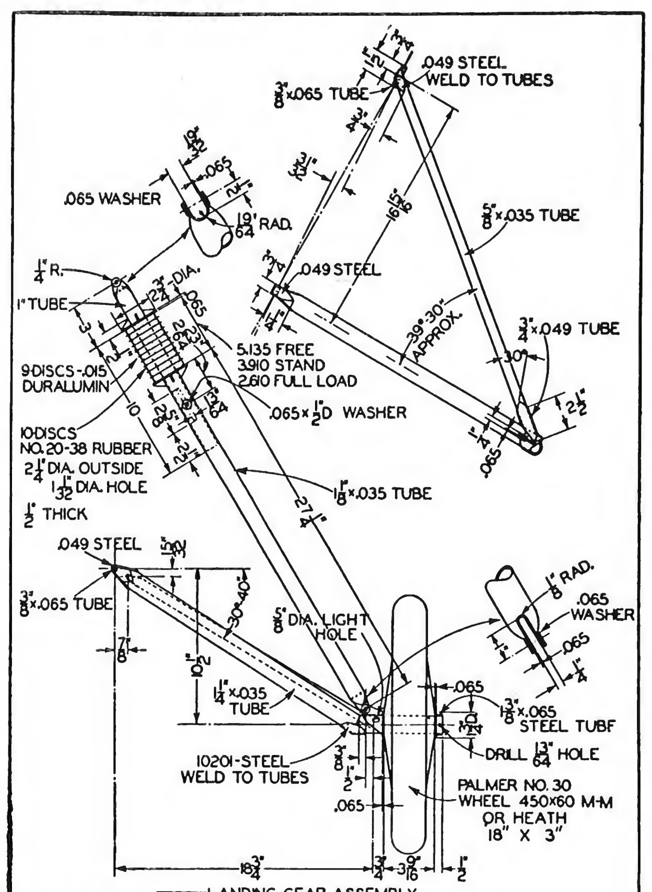
The tiny Driggs Dart draws an admiring crowd under the wing of the huge three-engined, all-metal Ford during the 1926 Ford "Airplane Reliability Tour."

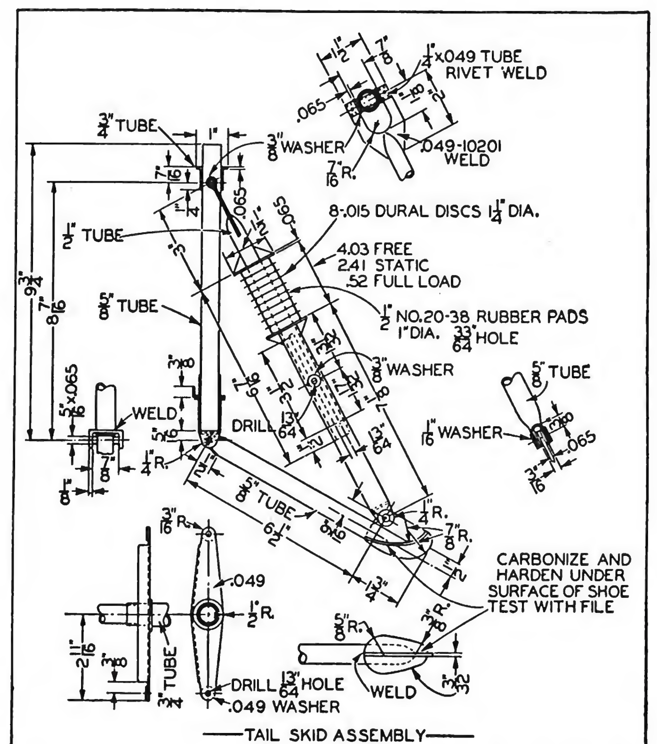


Here are the side view details—all that are necessary—to build the cabin seat of the Dart. Note the beautiful engineering that has gone into this design, and how easy the parts can be made. The seat is cushioned.



Fuselage details are in drawing above, and the design of the Driggs Dart I is now quite a few months old, and has been tried by time. Below is shown the granddaddy of split undercarriages, and is simple to make, and efficient.

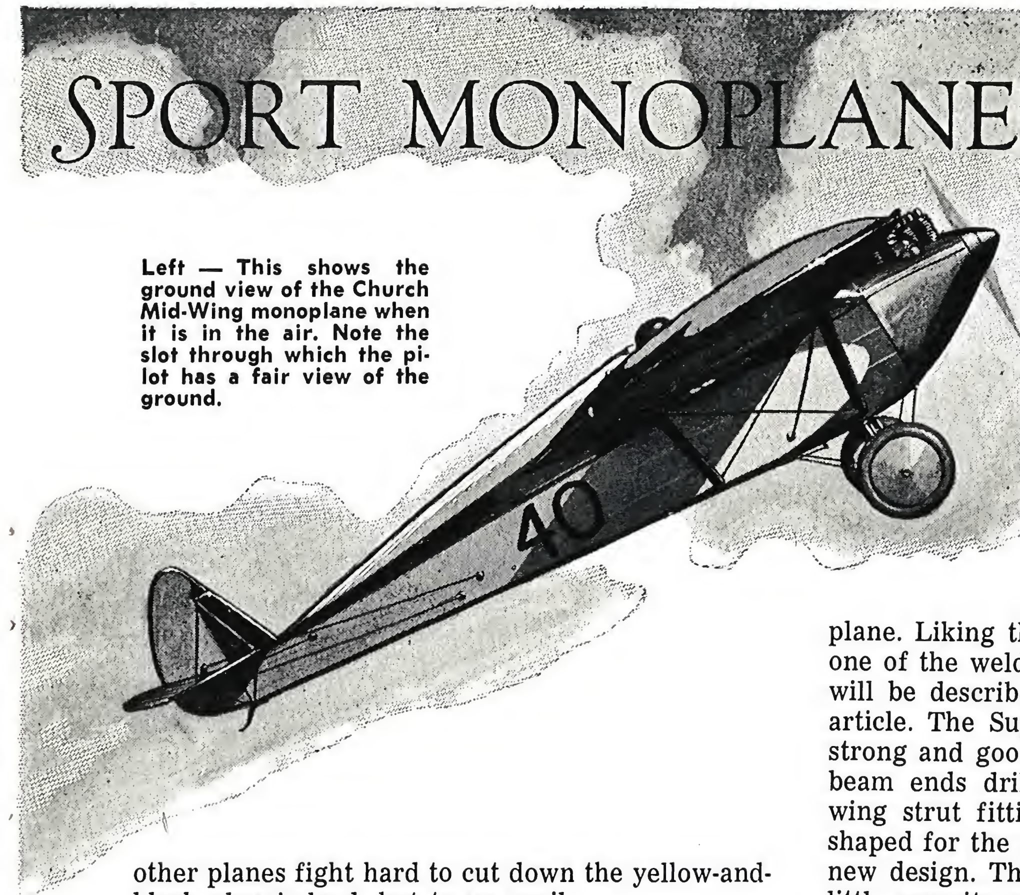




The very clever Driggs Dart I tailskid makes use of rubber rings to absorb shock. There is little recoil in such an arrangement. Note the compression figures under load.

SPORT MONOPLANE

By Stewart Rouse



Left — This shows the ground view of the Church Mid-Wing monoplane when it is in the air. Note the slot through which the pilot has a fair view of the ground.

Standard Heath Parasol parts are used plus the Church conversion parts in making this high-performance ship. Note the reduction of parasite resistance.

other planes fight hard to cut down the yellow-and-black plane's lead, but to no avail.

Imagine the thrill of the pilot, with throttle wide, cleaving along in the lead, pylon after pylon, lap after lap. With the crowd No. 40 is clearly the favorite, when, just at the beginning of the fifth lap her pilot's heart sinks to hear that all is not well with that little hummingbird of a motor in the nose, for it falters in its steady roar and limps bravely on, on three cylinders, and Freddie Lund has to land in honorable defeat while his opponents stream past overhead in quick succession. Being in walking distance of the grand stand pylon, Freddie walks over and is met by a disappointed but still smiling, yellow-haired, large-framed young man. They talk the race over. This genial looking man is James Church, designer and builder of the Church Mid-Wing, and an interesting train of events has brought him this day to the races.

Jim is a technical man. He has been designing electric elevators and large machinery in Chicago for several years with good success. He was badly bitten by the airplane bug as a boy and has never even showed signs of recovery from the bite. Consequently, he built and flew one of the first Heath "Parasols" in Chicago three or four years ago. This one had Thomas-Morse scout wings. Ed Heath used to fly it so high you could hardly see it. It was somewhat faster than the "Super Parasol" type, but would not climb so fast.

In the winter of 1928-1929 Jim built the first Church Mid-Wing Sport Monoplane. He built it from raw material. He could have built any other type, but this type seemed to him the ideal lightplane. Liking the Super Parasol fuselage, he built one of the welded type with minor changes which will be described in the technical portion of this article. The Super Parasol wings are also mighty strong and good, so he built a pair with the wing beam ends drilled with different holes, and the wing strut fittings he replaced with longer ones shaped for the new angle of the wing struts in the new design. The idea was to build a ship with as little parasite resistance as possible.

He built a sort of steel tube super structure at the cockpit opening, to support the wing butts about 2 in. above the top longerons of the fuselage which would give the pilot downward vision between the wing and top longeron. The regular streamline wing struts of the type used on the "Super Parasol" were used, only in shorter length. A nice snug cowling and turtleback were built which resemble those of the "Baby Bullet", and the propeller was provided with a spinner. As the tanks are in the wing butts as in the Super Parasol, and as this does not give sufficient fall from the tanks to the carburetor, it was necessary to install a Church Special Extra-Long Carburetor Flue on the Heath-Henderson engine used in the Church Mid-Wing to place the carburetor low, for more gravity fall. Rather unaccountably this long flue gave Jim's Heath-Henderson 3,000 instead of its usual 2,800 rpm, an increase of 200 revs!

As the ship neared completion it looked so nice and the motor worked so well that Jim decided to enter it in last year's National Air Races at Cleveland. He sent in his application in April and was pleased to receive a notification from the race committee that his plane was entered in the Closed Course Race Events, Event No. 2, for planes powered with motors of 100 cu. in. or less. Finally the yellow-and-black Church Mid-Wing Sport Monoplane was finished and ready for flight tests.

The day of the flight tests was just right. Jim was in a fever of anticipation and I was almost as eager as he. Ed Heath test flew the new lightplane

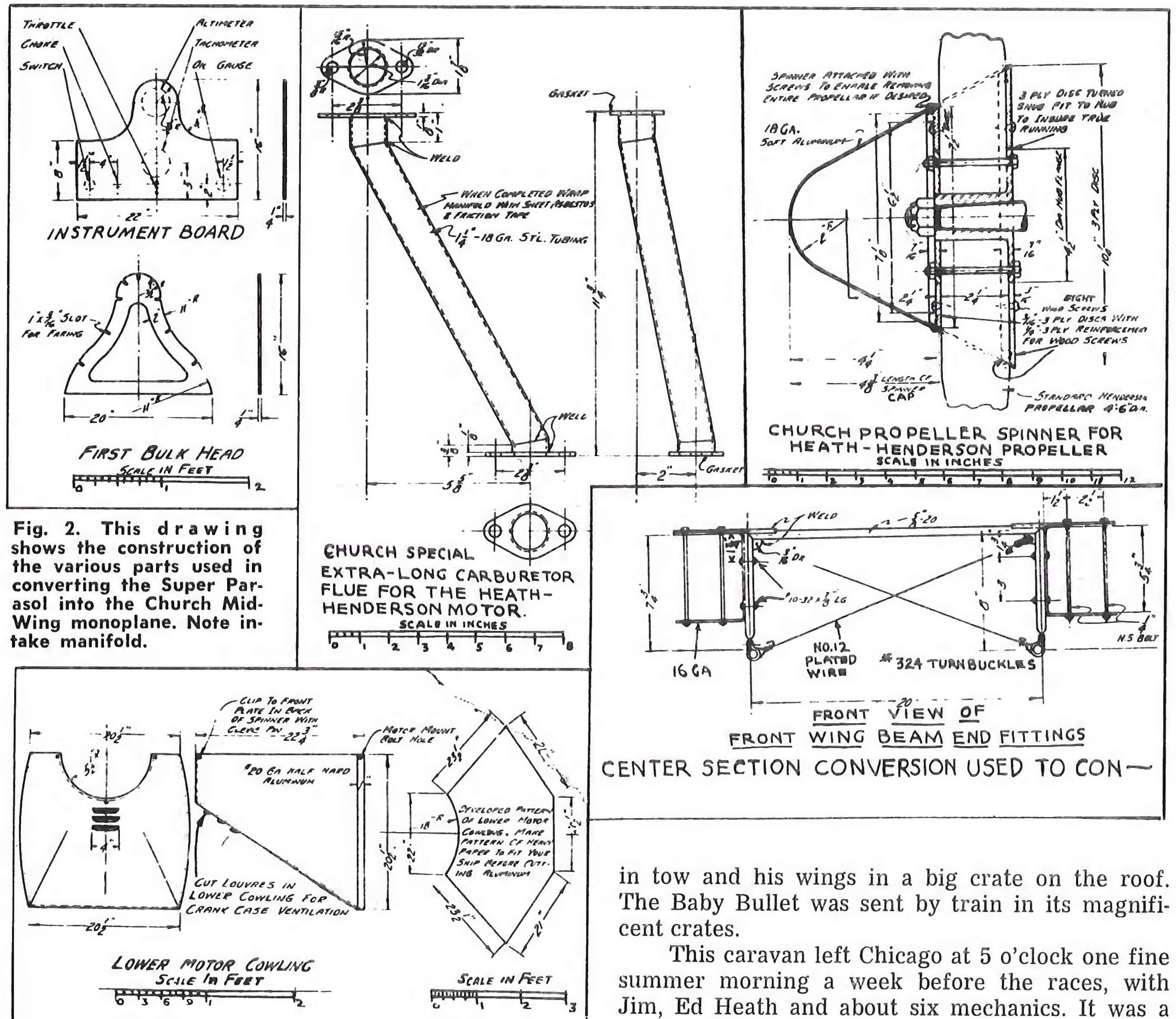


Fig. 2. This drawing shows the construction of the various parts used in converting the Super Parasol into the Church Mid-Wing monoplane. Note intake manifold.

and it surprised us all. Its top speed was around 90 mph and we couldn't see that it landed any faster than a regular Super Parasol. One thing that impressed us was the easy way a pilot can climb in and out of the cockpit; this is well shown in Fig. 8. As the ship was all right it was disassembled and taken back to Chicago for shipping preparations. The motor then received final adjustment and the *black walnut* racing propeller of 4 ft. 6 in. diameter and 2 ft. 4 in. pitch was completed.

The National Air Races were from August 24 to September 3. Jim Church secured a vacation from work for this period, and the week preceding it. Ed Heath and Jim decided to form a caravan and tow their entries to Cleveland. Ed's well known old 12-cylinder Packard school truck, with pictures of airplanes printed all over it like a circus wagon, was to lead with two "Super Parasol" race entries, the fuselage of one being in tow. Jim was to follow in his Buick with his Church Mid-Wing fuselage in tow and his wings in a big crate on the roof. The Baby Bullet was sent by train in its magnificent crates.

This caravan left Chicago at 5 o'clock one fine summer morning a week before the races, with Jim, Ed Heath and about six mechanics. It was a picnic. At first they were afraid to turn corners for fear of hurting the fuselages, but as the 400 mile trip wore on, the speedometer on the old Packard truck was hanging between 60 and 70 mph and the wheels of the towed fuselages had to be greased about every 45 miles. Some of the bumps threw the fuselages in the air, but they were undamaged. They made a fast trip, for Jim's Buick had a hard time keeping up, and that's saying something. The odd caravan attracted a lot of attention whenever it stopped en route.

On arriving at Cleveland the Heath-Church caravan drove to the Cleveland Municipal Airport, about 15 miles from the city's heart. On arriving at the airport, they were accorded royal courtesy and attention by the various committees. They were given large hangar space together. Setting up the planes was great sport and everyone enjoyed it. A crowd of spectators was always on hand and some of the comments they made were amusing. They insisted that the Church Mid-Wing was the Baby Bullet. Many thought the Bullet was a model airplane and were astounded to see Ed

All Air Force Photos from Jack McRae

U.S. Army Air Corps used this Driggs Dart 1 for wing slot tests.

Army officers look over the Driggs Johnson DJ-1 at the 1924 Dayton Air Races.

on both sides just at the rear edge of each bottom cross tube line a series of 2 by 4 yellow pine members, about 4 ft. long at the rear and 6 ft. long at the front. These members will support the fuselage jig proper. Thirty inches from the surface of the beams mark a line on each of these uprights. This may easiest be done by the use of a piece of wire after laying out the front and rear uprights. By stretching the wire tightly a straight center line along the sides of the uprights is insured. This line so obtained on the outside of each corresponds to the thrust line marked on the drawing. Be sure that all uprights are square with the surface before nailing.

Next obtain some $\frac{3}{4}$ by 4 Yellow Pine for cross members. Measure down and up on each upright to

Driggs Johnson DJ-1 had windows removed for the 1925 Air Races at Mitchell Field, N.Y.

PLANS FOR BUILDING THE DRIGGS DART

Driggs Dart competed in 1926 National Air Races at Philadelphia.

By Ivan Driggs

The *Dart I* whose construction is illustrated and described in this article is one of the most successful and practical of American single seaters. This airplane with the Henderson motorcycle engine won the greatest proportion of the prize money at the 1924 Air Races. The same design with the Wright Morehouse two-cylinder engine took part in the Ford Tour of 1926 and subsequently flew over the mountains from Moundsville, W. Va., to Washington, D.C., and from there to Philadelphia to compete in the races there. In making this flight the *Dart I* left a great many larger planes behind due to bad weather.

The only light plane at present owned by the U.S.Air Corps is a *Dart I*. It is used by the Engineering Division at Wright Field in the development of wing slots. This design was made under contract to the Air Corps and *the stress analysis has been checked by the Engineering Division.* No one need fear that this airplane, if properly constructed, will be structurally unsafe.

To build the *Dart I* a good knowledge of cabinet making and welding is necessary. No one should attempt it unless he possesses that knowledge or is able to engage the cooperation of one who does.

In building anything, it is usually best to begin by building the most difficult item first. Consequently we will first start the construction of the fuselage, though the wing might at first seem to offer greater difficulties. Such however is not the case, and there really is nothing tremendously difficult in the construction of the whole plane. Take two long beams that will later be used as cauls in building the wing beams, and make of them a base for the fuselage jig. This is made by supporting the beams on four saw horses, and leveling them up about two feet apart. They should be firmly nailed to the horses. Starting from the front of the fuselage, each station should be laid out with a sharp pencil on these beams, using a carpenter's square to insure that the lines are absolutely square with the center line. Then lay out the various lower cross tubes at each station. Erect at each station

Heath get in and fly away with awful velocity. *It was noticed, though, that no airplanes attracted so much attention and appreciation as the lightplanes.*

Newspaper men took numerous photos of the Church Mid-Wing Sport Monoplane in action, and large pictures and remarkably inaccurate stories about Jim and his "wonder plane" appeared in the papers; in fact, in reading about himself Jim learned many new things about his history that he didn't know himself. Newspaper accounts are like that. Mostly hooey.

The races were wonderful to watch and Jim could hardly wait until his plane should be in competition. Two days before the Race Committee told Jim that, as his pilot did not have the F.A. 1 rating, he could not race. Naturally Jim was greatly disturbed by this bad news. In Freddie Lund, Waco test pilot, and holder of the civilian outside loop record, a matchless pilot, he found a real friend,

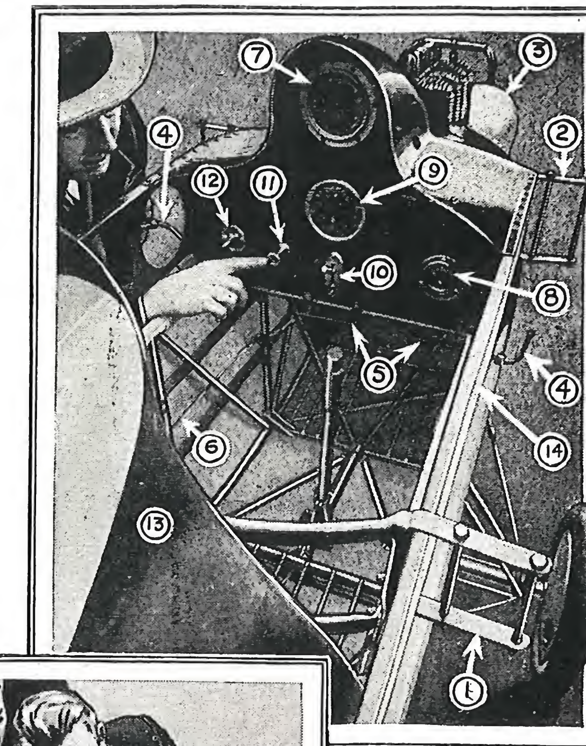


Fig. 5. A view of the Church mid-wing monoplane looking forward. Note the neat instrument board. A guide to the parts will be found at the end of this article, properly numbered. In the foreground note the rear wing beam fitting and the two curved tubes joining it with its companion fitting on the left longeron. There really are but very few parts needed to make the conversion. Reduction of parasite is attended by flatter bracing.

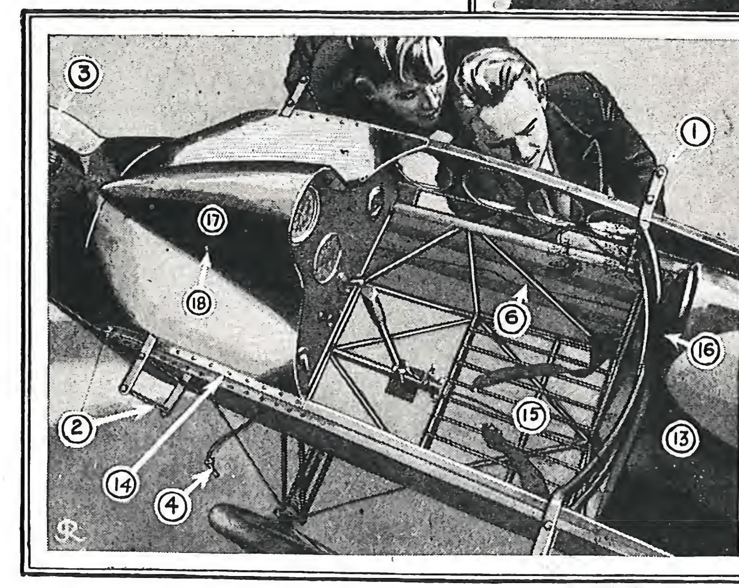
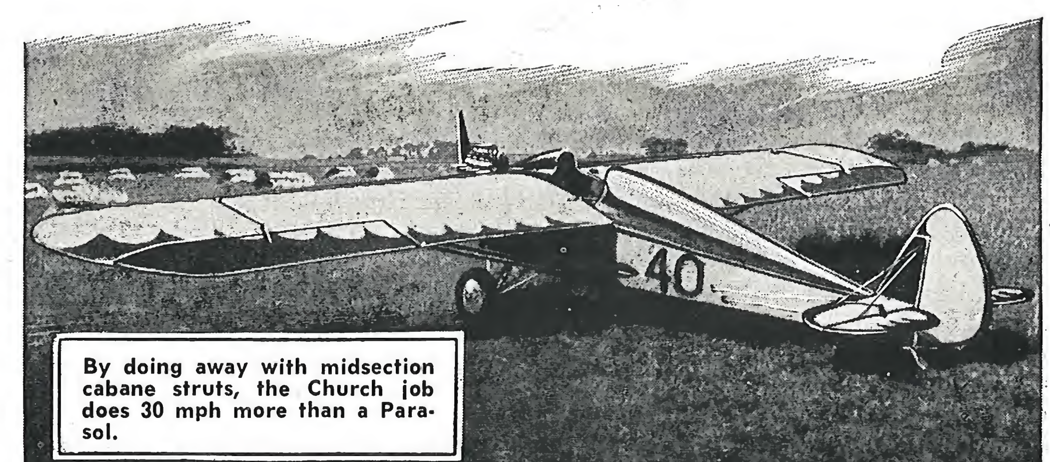
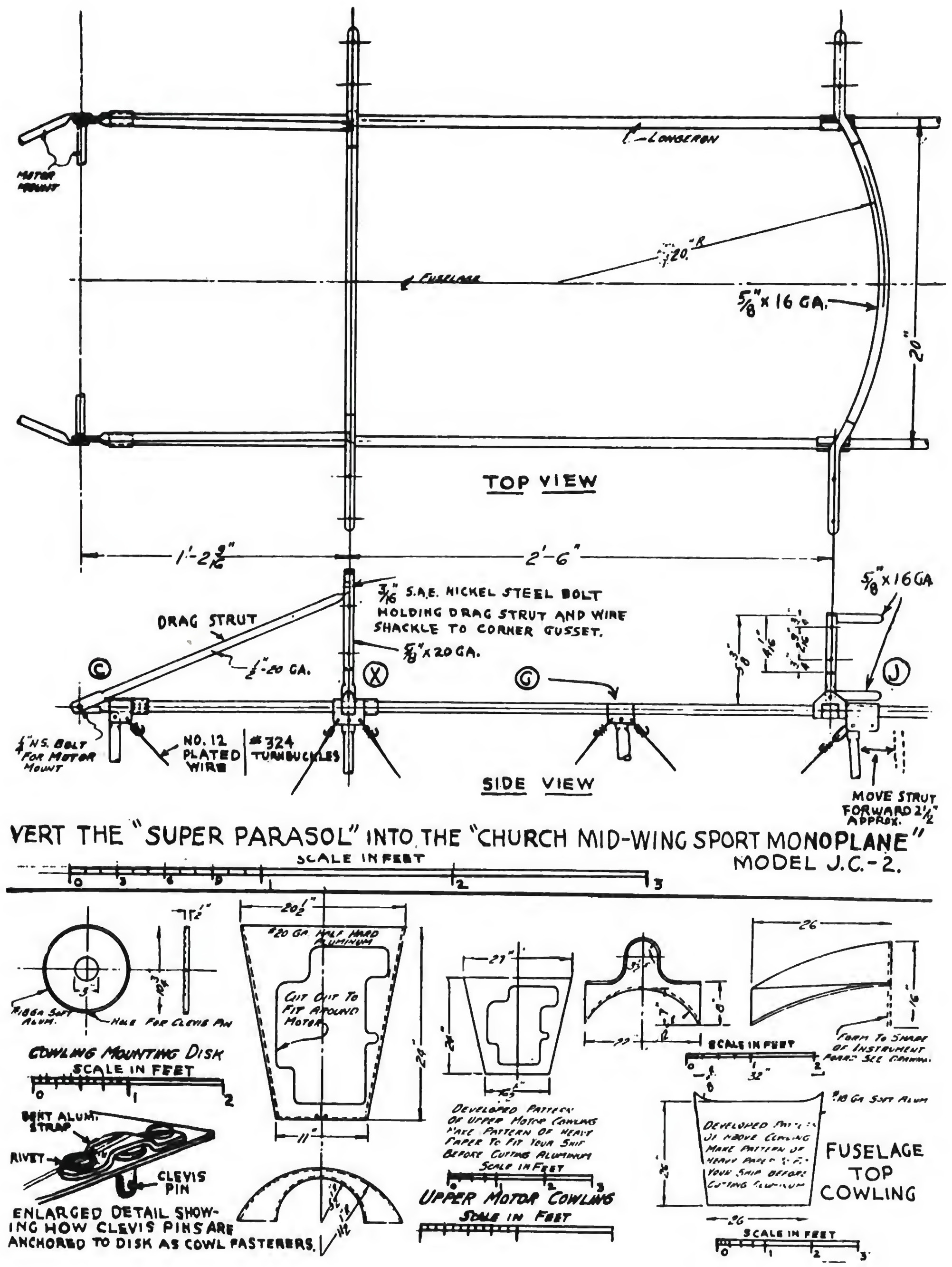


Fig. 6. Jim Church points out an interesting point of design to Stewart Rouse, airplane illustrator and author, and producer of this article.



By doing away with midsection cabane struts, the Church job does 30 mph more than a Parasol.



For some strange reason the longer manifold, installed so that the wing-butt tanks would have good gravity feed, revved the motor up 200 extra rpm. Here are cowling and compression strut details.

for Fred agreed to pilot No. 40, the Church Mid-Wing.

The day of the race arrived, the planes were wheeled forth to the starting line with a mechanic at propeller and tail. The motors were warmed, cameramen took their pictures and stood back, the starting gun was fired and the tiny ships were off in Event No. 2, Closed Course Races, National Air Races! How the motor of No. 40 failed has already been told. The exhaust valve in No. 3 cylinder warped because of an incorrect carburetor adjustment. But, win or lose, air racing is its own reward in high hearted sport; the gold prizes are not large, but that is not what the air racers race for!

Here are the general specifications of the Church Mid-Wing Sport Monoplane:

Span, 26 ft. 8 in.; chord, 4 ft. 6 in.; angle of incidence, 1 deg.; wing area, 110 sq. ft.; aileron area, 10 sq. ft.; elevator area, 5.2 sq. ft.; stabilizer area, 5.5 sq. ft.; rudder area, 3.8 sq. ft; length over all, 16 ft. 9 in.; height over all, 4 ft. 7 in.; weight, empty, 260 lbs.; rate of climb, (first minute), 650 ft.; useful load, 300 lbs.; gas capacity, 5 gals.; oil capacity, 6 qts.; high speed, 90 mph; landing speed, 28 mph; cruising radius, 400 miles.

Technical. Building the Center Section Conversion: We will assume that the reader is already in possession of a complete Heath "Super Parasol" Sport Plane or its plans with either the bolted or welded type fuselage, and familiar with its constructional details. In the bolted type it will be necessary to move the longeron fitting at "J" for-

the rudder is covered with 7/32 in. plywood. The leading edge, which is of spruce, is notched to accommodate the ribs.

The control horn for the rudder is made of ¾ in. spruce cut to the dimensions given. Two holes of 7/32 in. are drilled through both tips of the horn ¾ in. from the outside edge. The overall dimensions of the horn are 10 in. Note that the detail of the trailing edge construction is typical for the complete tail construction. The beam of the rudder is of ½ in. spruce. Gusset plates are of 3/32 in. plywood, and the bottom of the rudder is of the same material.

The metal fittings of the glider are shown in the accompanying drawings. They are made of carbon steel, of the gauges specified. The designs are first laid out on the metal and then cut out with a cold chisel. It is essential here that the dimensions be followed closely.

In making the launching hook, it will be necessary to cut out two pieces of the same dimensions. These two pieces are welded together to form the completed hook.

To perform the bending operations which are required in making the clamps and the spar bracket, place the piece in a vise just below the line of the bend and pound evenly all along the line with a heavy hammer. Neatness will depend upon the evenness of these bends.

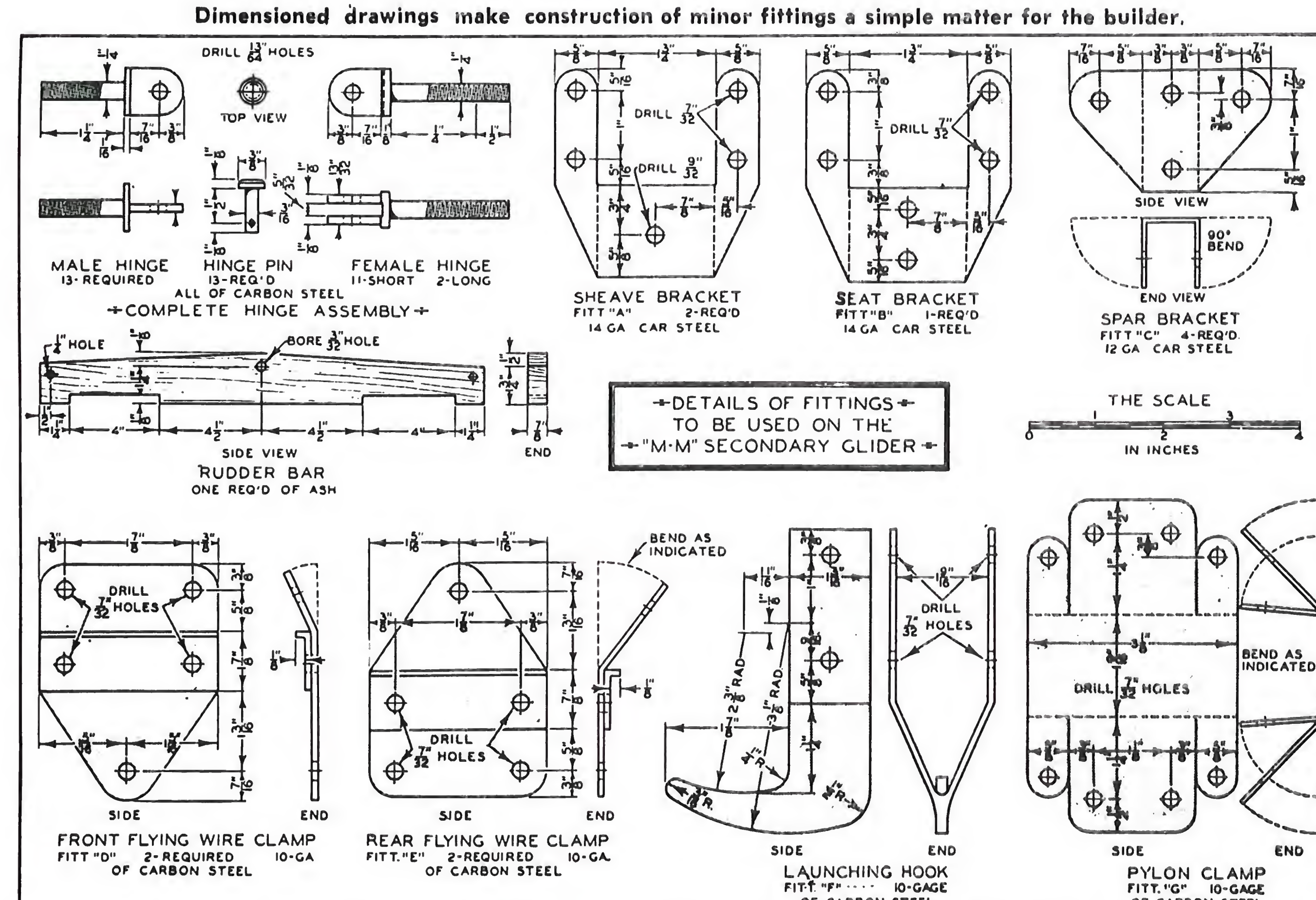
The rudder bar is made of 7/8 in. ash of the dimensions shown. The rudder control wires are looped through the ¼ in. holes in the ends.

The drawing showing details of the control stick and torque tube construction presents all necessary information in graphic form. The torque tube is made out of aircraft tubing of 1 3/16 in. diameter, with 3/64 in. walls. The control stick yoke is bent around the torque tube as shown and held in place with four rivets. The torque tube is held in place by a bearing strap of 10 gauge cold rolled steel bent around the tube and screwed to the top runner brace. The tube rests in a wooden bearing block.

The control stick itself is made of aircraft tubing of the same dimensions as the torque tube. A detail drawing of the end of the control tube shows how a 2 in. pulley is mounted on the end of the tube, through which the cables run to the elevators. The yoke which holds this pulley in position is made of 12 gauge cold rolled steel. This is a little heavier than the grade used for the control stick yoke and the bearing strap, since there is more strain on this part and it is vitally important that it should stand up.

A profile view of the cockpit is shown in one of the drawings. Inasmuch as individual pilots will prefer to exercise their own ingenuity on this item of construction, details are not given. • • •

Dimensioned drawings make construction of minor fittings a simple matter for the builder.



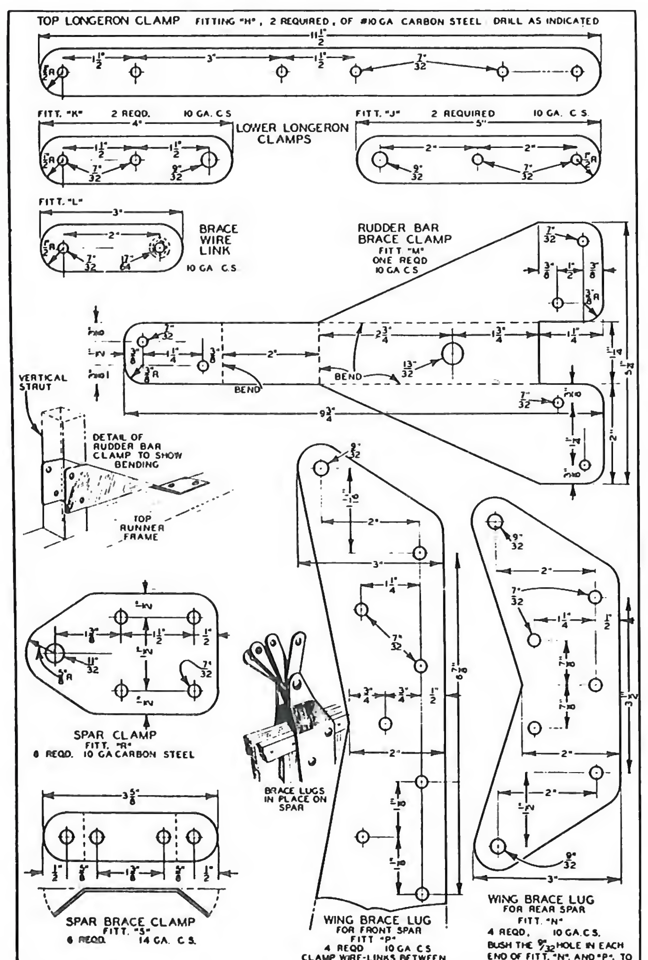
used at the roots of the spars to hold the spar brackets. A mortise is cut one foot from the root so that the horizontal braces may be set in flush with the edges of the root piece. A 3/8 in. slot is cut from the same mark to hold the plywood web.

After the end of the web has been inserted into the slot of the root piece the braces should be applied as shown on the plan, using casein glue and 1/2 in. bright wire nails. It is hardly necessary to state that extreme care should be taken with the nailing in order that the wood remain undamaged.

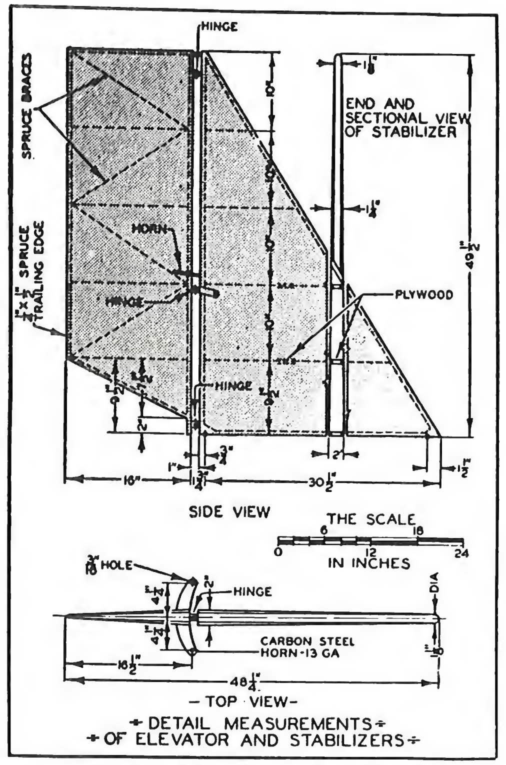
Inside the ninth horizontal brace a 6 in. filler of 3/16 in. plywood is placed on the both sides of the beam, and it is over this that the wing brace clamps are nailed. The construction of both front and rear beams is identical except for the vertical dimensions. It is well to use a long table or bench, or spread the beam between saw horses while doing this work.

It will be necessary to construct a jig before tackling the construction of the wing ribs. In making this jig you will save time if you will draw out a full size rib outline on a board or on heavy paper tacked to your work bench. The jig form may then be nailed around your outline and you are ready for work.

Starting with the leading edge, the nosepiece is cut from fiber as shown on the wing rib drawing. A notch is cut in the tip into which the nose stringer will be fitted. One cap strip of 3/16 in. square spruce is then placed in the jig. The rib webbing of 1/16 in. plywood is then placed in position with the spruce stiffeners already in place. The other cap strip is then fitted into the jig and nailed in place on 3 in. centers. The aileron ribs are constructed in like manner and are cut off back of the rear beam.



Metal fittings include longeron clamps, spar clamp, and wire link.



Follow this drawing in making the elevators and stabilizers.

You are now ready to assembly your wing section. If the ribs have been accurately built you will find that they will slide snugly into place over the spars, where they are nailed in place through the cap strips. When all are in place the 1/2 in. square nose stringer will be inserted into the leading edge of the rib and glued. The .02 aluminum trailing edge will then be bent and placed on the tips of the ribs, where it will be secured with 24 gauge aluminum wrapper clips.

The 1/2 in. 20 gauge tubing will then be placed on the tips of the spars and bent to slip over the rounded end of the spruce nose stringer. Next the drag struts are placed on each side of every third rib and the drag wires are strung as shown. The next step will be to place the duralumin leading edge in front of the front beam. Your wing is now ready for covering with fabric and doping.

Now we come to the rudder. You'll find a drawing of the complete assembly which should serve to clear up any doubtful points. The ribs are of spruce, with 3/32 in. plywood spacers glued and nailed. Flat head copper nails are used for this operation. A detail of the trailing edge shows how 1/4 in. by 1/2 in. spruce is used, with 3/32 in. plywood gusset plates. From beam to leading edge

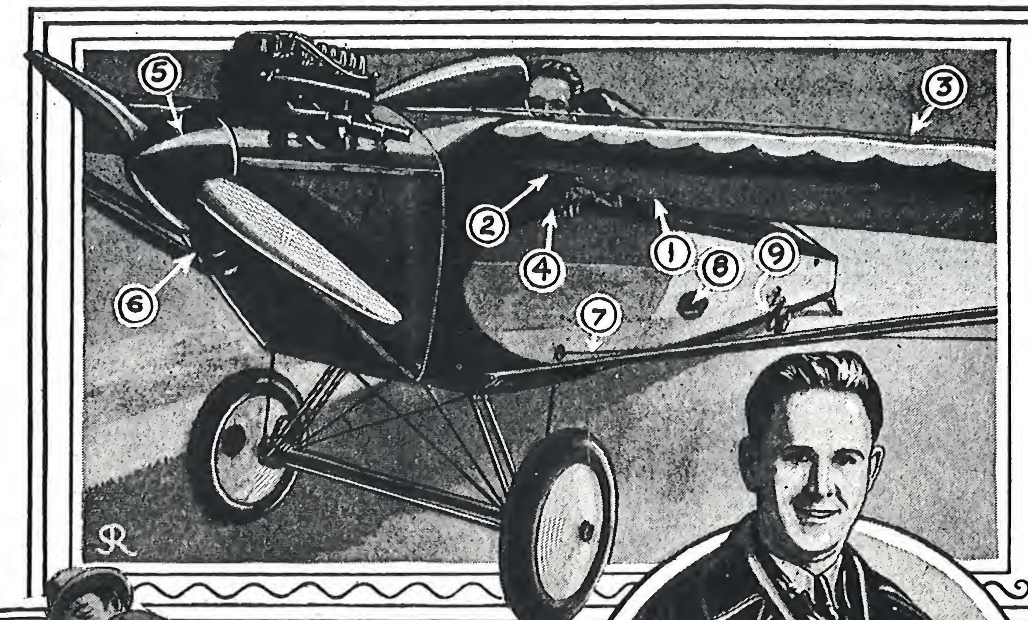
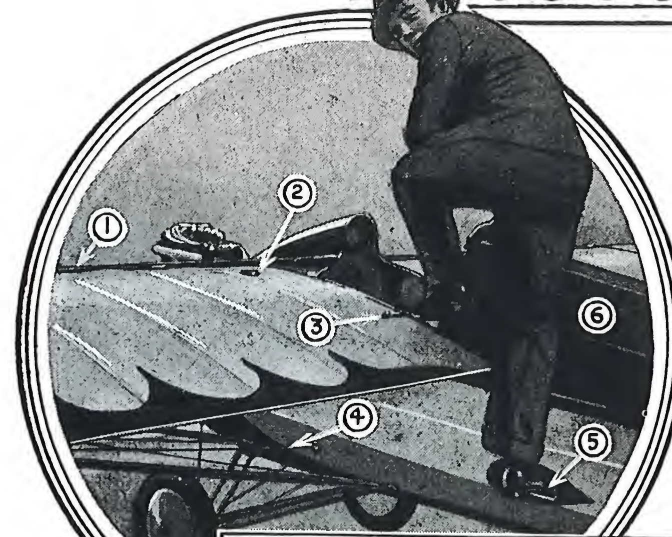


Fig. 7. Front quarter view. 1, rear beam fitting; 2, front beam; 3, link cable; 4, gas line; 5, spinner; 6, louvres; 7, aileron cable; 8, step; 9, elevator control cables. Pilot is snugly cowled. Note vision space where pilot's hand extends.



Jim Church himself, one of America's lightplane authorities.

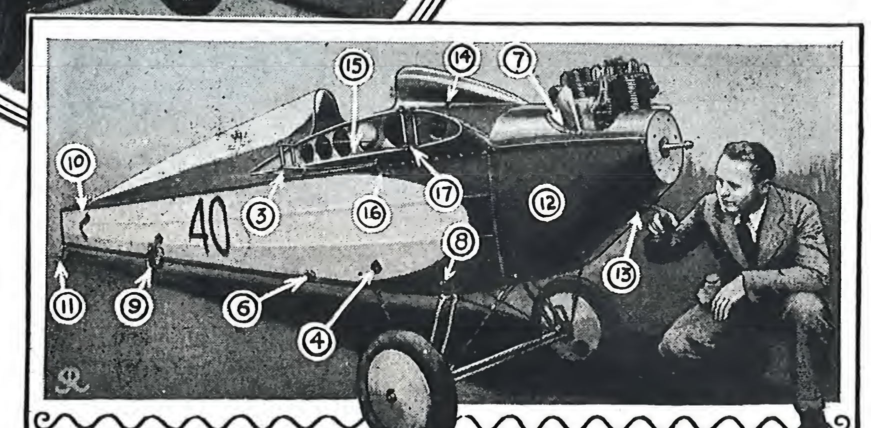


Fig. 8. The Church Mid-Wing is easy to enter. Key to details—1, link cable between top aileron horns; 2, gas filler cap left wing; 3, left wing rear beam fitting; 4, aileron cable to stick; 5, step; 6, turtle-back; 7, air scoop; 8, front flying strut fitting; 9, elevator control cables; 10, rudder cable; 11, tail skid; 12, bottom motor cowl; 13, Church shows louvres; 14, hole for aileron cable; 15, wing butt socket; 16, gas line to right wing tank; 17, front wing beam fitting.

ward about 2 1/2 in. See Fig. 2. This done, another wrap-around 18 ga. longeron fitting must be made and fastened in place on the longeron, with a rivet made from a 2 penny shingle nail; just in front of fitting "J" and separated from it by a 1/8 in. space to hold the loop ends of the No. 12 plated diagonal brace wires which cross inside the fuselage at this point. The large, newly made fitting just described embraces a simpler wrap-around longeron fitting of 18 ga. sheet steel, the inward pointing ends of which hold the horizontal brace wires of the horizontal bay behind the pilot's shoulders. The upward pointing ends of the large fitting embrace the lower flattened end of the rear vertical strut of the center section conversion to which it is attached with a 3/16 in. nickel steel bolt. Note that whenever a tube is flattened at its end a 3 in. reinforcement of the next smaller size tubing of the same gauge

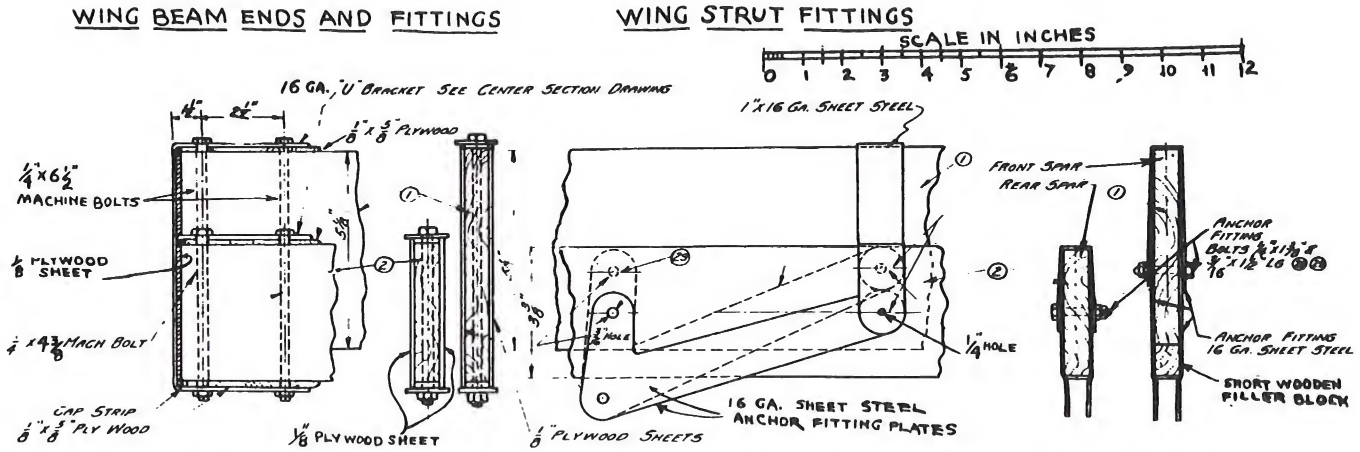


Fig. 3. This drawing shows the construction of the wing beam ends and the changes in the strut or flying tube fittings. Due to the lower angle of the flying struts the angle of the spar fitting must be changed to correspond. The center drawing shows both front and rear placings.

must be slipped in the end to be flattened, and the flattening must be done with the tube end red hot. All four vertical struts of the center section conversion are made in this way of 5/8 in. by 20 ga. Shelby seamless tubing. Their tops are cut as shown in Fig. 2, at 45 deg., and the horizontal top struts are laid on and their 45 deg. cut ends welded to the tops of the vertical struts.

Vertical Struts

Note that the rear pair of vertical struts are connected top and bottom with curved horizontal struts, see Fig. 2, Fig. 5 and Fig. 6. The top curved strut is welded to the vertical strut tops, and the bottom curved strut has its flattened and bent ends held by the 3/11 in. bolts, which hold the rear vertical struts to their longeron fittings. These curved horizontal struts are of 5/8 in. by 16 ga. tubing. They are bent by filling them with sand, plugging the ends with wood plugs and bending them gradually around a curved surface. The sand keeps the tubing from crushing. When bent to the right curve, let out the sand and cut the ends properly. The wing beam end fittings, see Figs. 2, 5, and 6 are made of 16 ga., half-hard cold rolled steel which is the grade used for all metal fittings. These fittings are shaped as shown and welded and bolted with 10-32x7/18 in. machine screws to the vertical struts.

The holes for these bolts must be reinforced by short tubes welded in the holes. Note that the upper portion of these large clevis-like fittings is two ply and welded together along its edges. The top ply extends inward along the top of the top horizontal strut for several inches and is welded to the horizontal strut. The front bay of the center section conversion formed by the front vertical struts and the horizontal top strut between them is braced by a pair of diagonal No. 12 plated wires with No. 324 turnbuckles. These wires are fastened at their lower ends by looping the longerons, and at their upper ends by a shackle fastened to a 3/16 in. bolt through a 16 ga. gusset welded in the angle of the vertical and horizontal struts. This same 3/16 in. nickel steel bolt also holds the flattened and bent end of the sloping 1/2 in. by 20 ga. drag strut, the lower end of which, flattened and drilled, is held by the 1/4 in. nickel steel motor mount bolt passing through the front end of the top longeron.

Corresponding changes in the welded type fuselage can easily be effected.

Changes Necessary in the Wings. The wing beam ends must have new holes bored in them as shown in Fig. 3, two in each wing beam. One of these holes is 1 1/2 in. from the end, the other 4 in. from the end. They are drilled down vertically for the 1/4 in. nickel steel bolts of the wing beam end fittings.

New wing strut fittings must be made of 16 ga. sheet steel and attached.

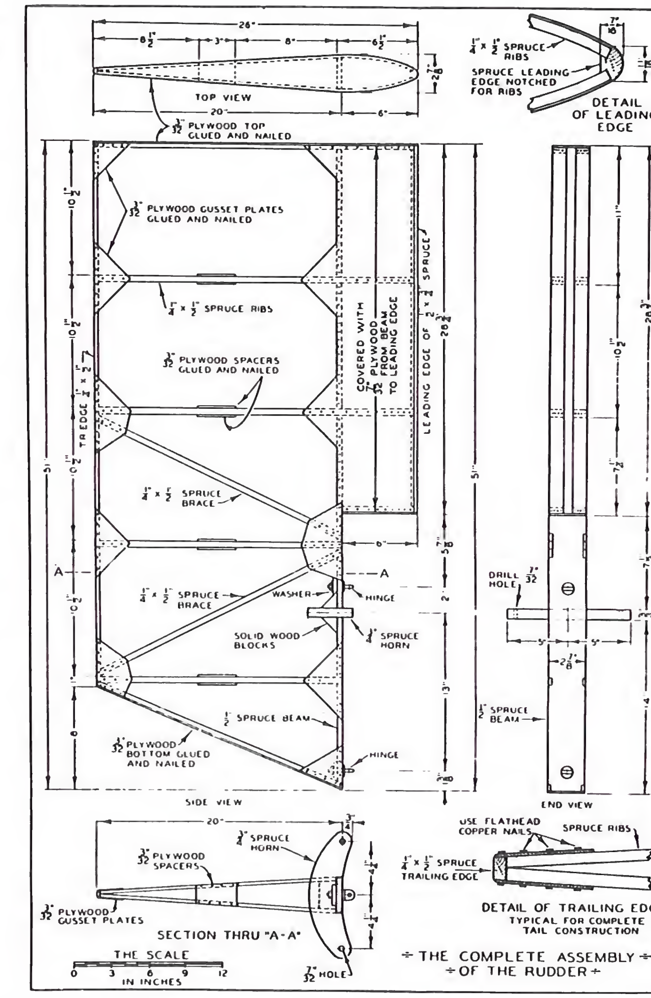
The wing struts must be shortened, the drag and anti-drag cables and lower aileron cables shortened.

Changes in the Engine. The Church Special Extra-Long Carburetor Flue must be made up of 1 1/4 in.-18 ga. steel tubing as shown in Fig. 2.

Cowling. 18 ga. half hard aluminum should be used for the parts of the cowling which require no beating in shaping. 18 ga. soft aluminum should be used for those which do. The windshield is the only part of the Church Mid-Wing's cowling which must be beaten. To shape the windshield it may be beaten over a small sack of sand with a rounded wooden mallet. While beating it should be softened occasionally by heating it a little with a blow torch and plunging it in cold water. The cowling plans in Fig. 2 should make the cowling simple. One point is especially worthy of note. The wing sockets have all the top cowling riveted to them with 1/8 in. aluminum rivets.

These sockets are made by nailing a sheet of 18 ga. aluminum between two 1 in. boards cut to the rib section of the wing, and flanging the protruding metal around the edges, over with a hammer. In Fig. 2, note how clevis pins are fastened in the cowl supporting disk, at the front of the motor cowling to hold the cowling. Fig. 2 should

Sturdy simplicity is keynote of the rudder design — ribs of spruce. With an overall length of 51 inches, the rudder has ample area.



to build. The main spars are built first, laid over the drawing, marked for the rib spacing, then the cap strips on one side glued down and tacked. The job is flopped over and the second set of cap strips is put on.

A small sheet of aluminum for the leading edge of the rudder borrows from the practice of the German aeronautical engineer who designed the Northrop Glider. It is effective, and simple to make.

With the fuselage and the tail surfaces out of the way the wings are the only remaining problem of any seriousness. These are made like a pair of wings I built a short while ago. The wire bracing is good, and standard Canadian practice, and the tips are the kind I find the simplest to make.

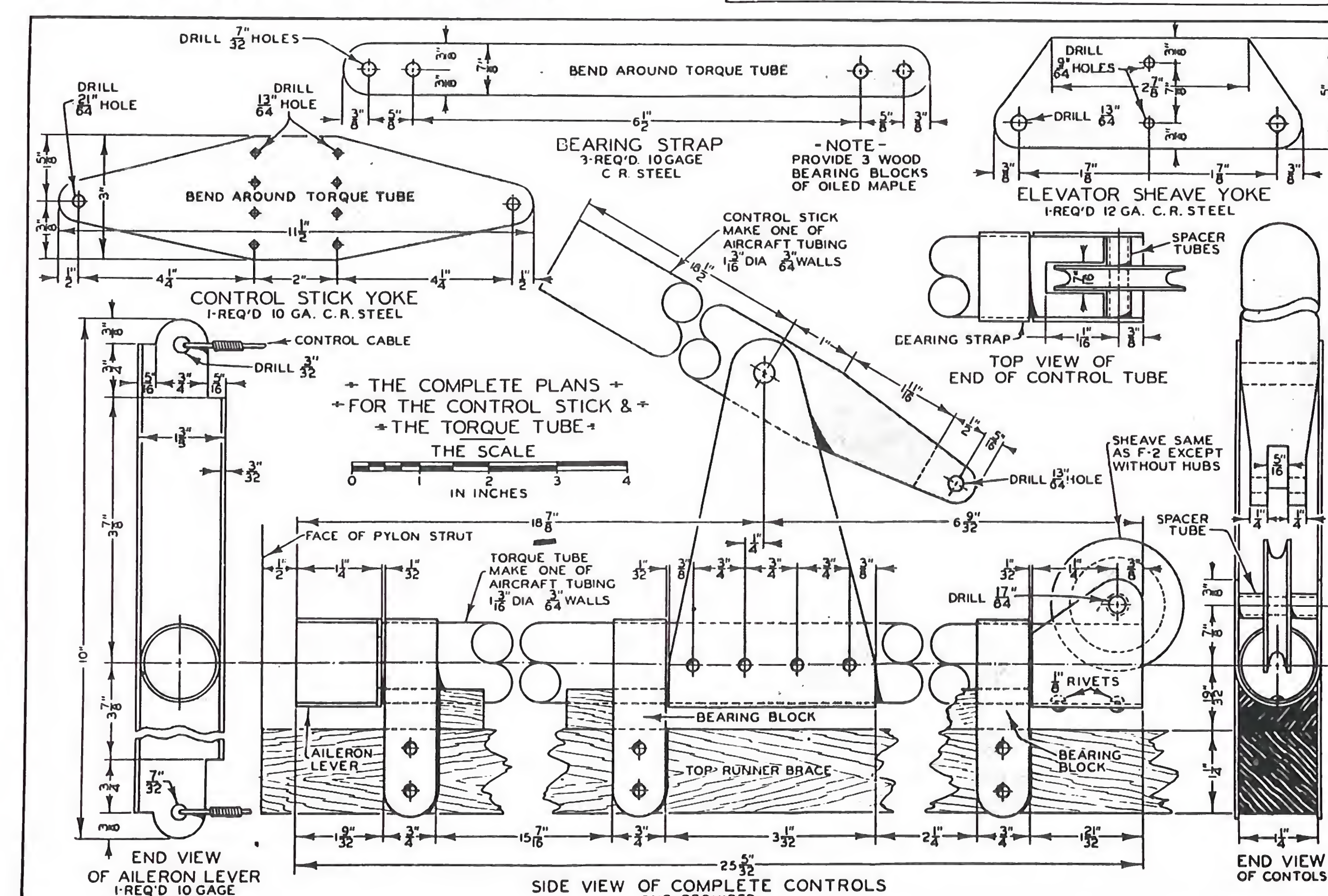
The spars are made of 3/8 in. plywood web with vertical and horizontal braces of 3/16 in. by 3/4 in. spruce.

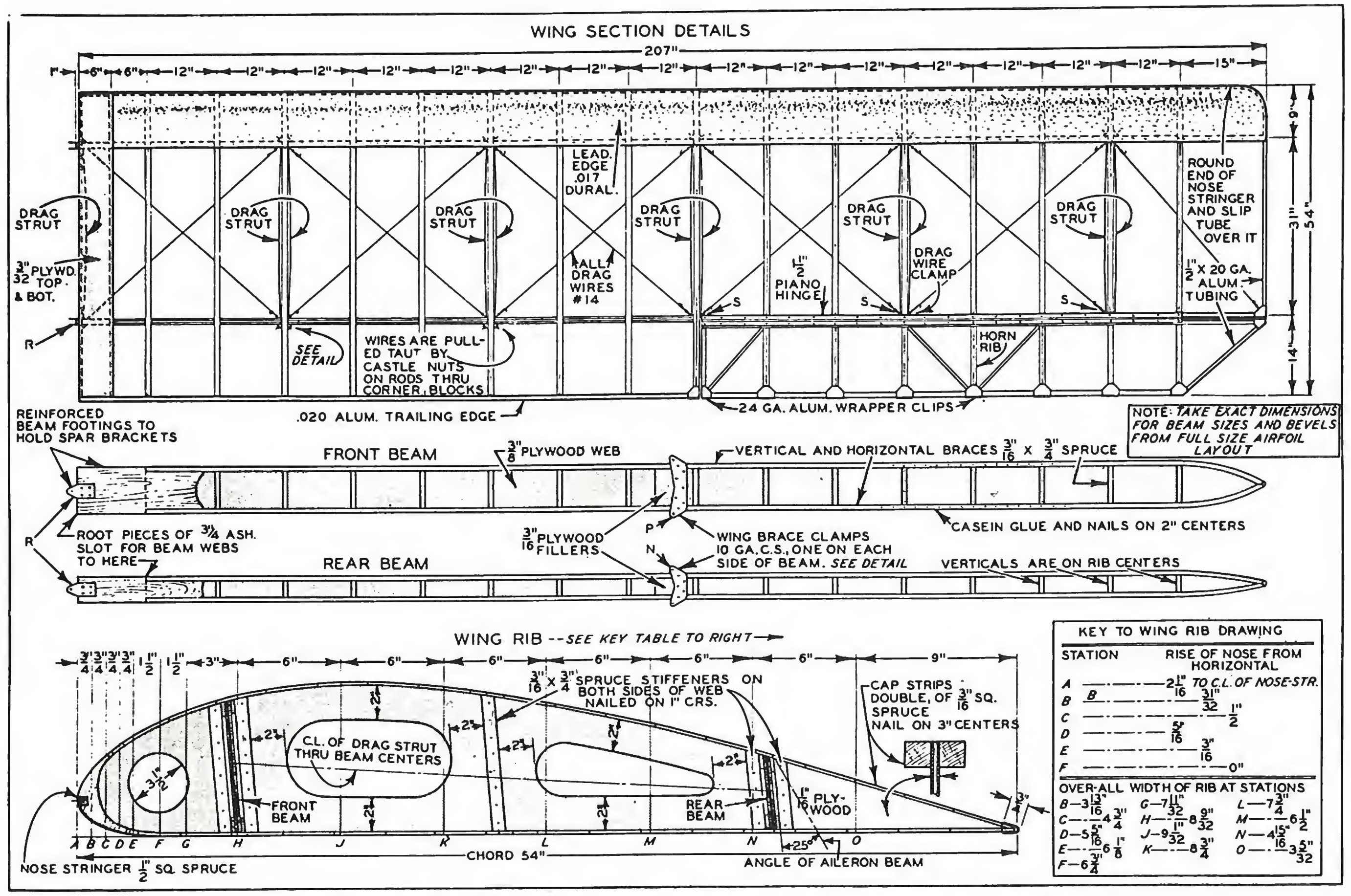
Do not attempt to use any other kind of wood for these braces, as airplane spruce is the only material having the requisite strength coupled with light weight.

The external depth of the front spar is 7 1/2 in., while that of the rear spar (or beam) is 4 in. Other dimensions for the beam sizes and bevels should be taken from the full size airfoil layout.

Reinforced beam footings of 3/4 in. ash are

All essential construction details of control stick and torque tube are shown in the drawing below.



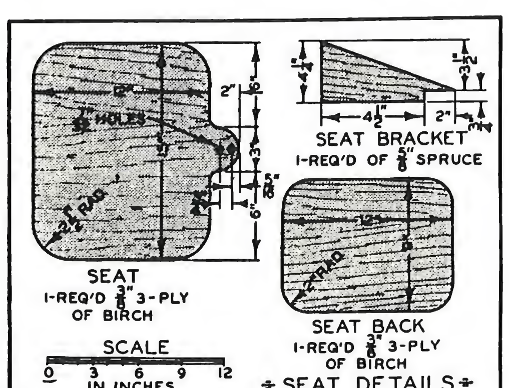


Here's the wing plan — follow it very closely for a successful glider

Of three bays, the fuselage is of the truss type. Plywood gusset plates on both sides of spruce struts, sized as the drawing on the opposite page shows keep the structure rigid.

The first step in building the glider is the laying out of the seat frame shown in cut No. 2. The dimensions for this piece are taken direct from the drawing and are put upon a piece of brown wrapping paper of a size sufficient to accommodate the lines. Then the pieces are tacked down, preferably through the wood itself with finishing nails to the floor or to the bench on which you are working.

Be sure that all the pieces of spruce butt up very closely. Do not rely on the gusset plates to



Follow this pattern in making the seat. Birch is used for the seat and back, spruce for bracket.

take up the compression strains that result as of landing, and so on.

Then cut out the plywood gusset plates. These are of 1/8 in. stuff as per the drawings. Put on the ones shown in Fig. 2 first. After these have been fastened then the large plates, shaped like a shoe horn, are fastened on.

The manner of gluing is simple. Casco waterproof casein glue is used. It can be purchased in almost any hardware store. It comes in the form of a powder, and is mixed with a *definite proportion* of cold water. Like a cement, it requires setting to hold well, but, unlike the old hot gluing process, it requires no particular pressure to make it hold well. It is applied with a paint brush, and evenly to both surfaces to come into contact with each other. Then the piece is nailed down just enough to make the kiss even all around, and the thing is forgotten. The wood will part before the glue gives in.

The same method is used for the building of the wings and the control surfaces. The drawings being complete, carry all the dimensions, and to repeat that here would be superfluous. Suffice it to say that paper plan, full size, is made and laid over the work bench or the floor on which you are working, and that all the pieces are cut to size very closely before fastening.

You will note that the tail surfaces and rudder, as in Fig. 1, are very simple, and should be easy

explain the propeller spinner sufficiently.

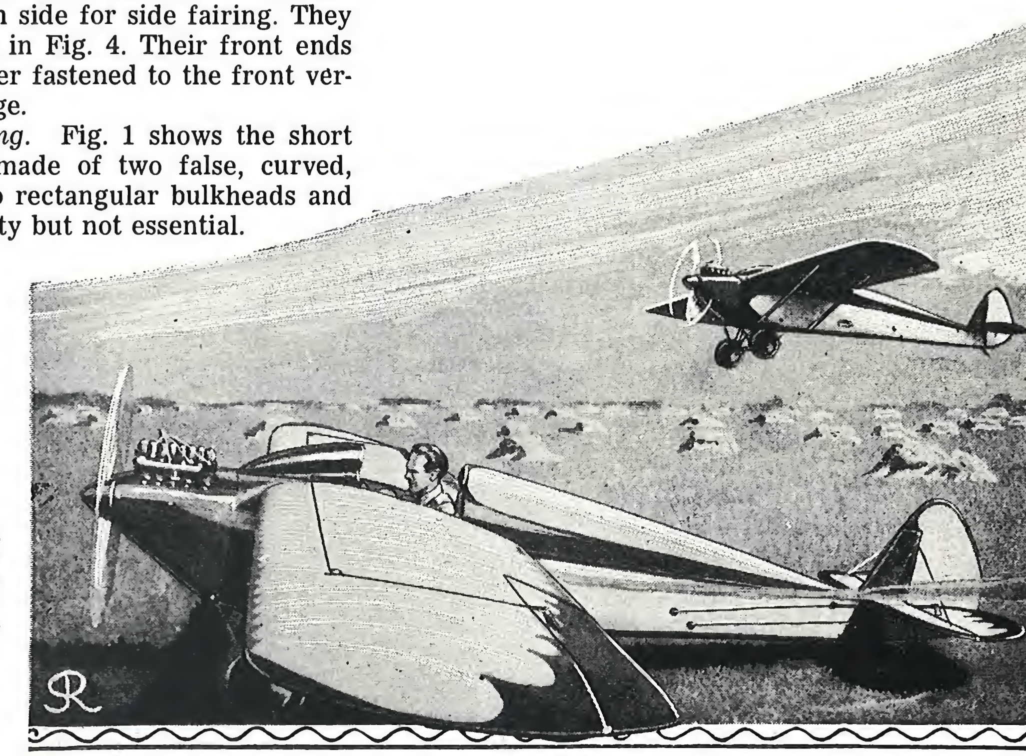
The Turtleback Fairing. The turtleback fairing should present no difficulty. The drawing of the first bulkhead is used as a start. There are three more bulkheads and a cross piece in front of the leading edge of the horizontal stabilizer. The height of these bulkheads can be scaled from Fig. 1, and their width is that of the fuselage at their position. They are fastened to the horizontal struts as shown in Fig. 4. Nine 1 in. by 1/16 in. stringers complete the turtleback.

The Side Fairing. Two 1 in. by 1/16 in. spruce strips are used on each side for side fairing. They are fastened as shown in Fig. 4. Their front ends fasten in a curved nailer fastened to the front vertical strut of the fuselage.

The Bottom Fairing. Fig. 1 shows the short bottom fairing. It is made of two false, curved, wooden longerons; two rectangular bulkheads and two fairing strips. Pretty but not essential.

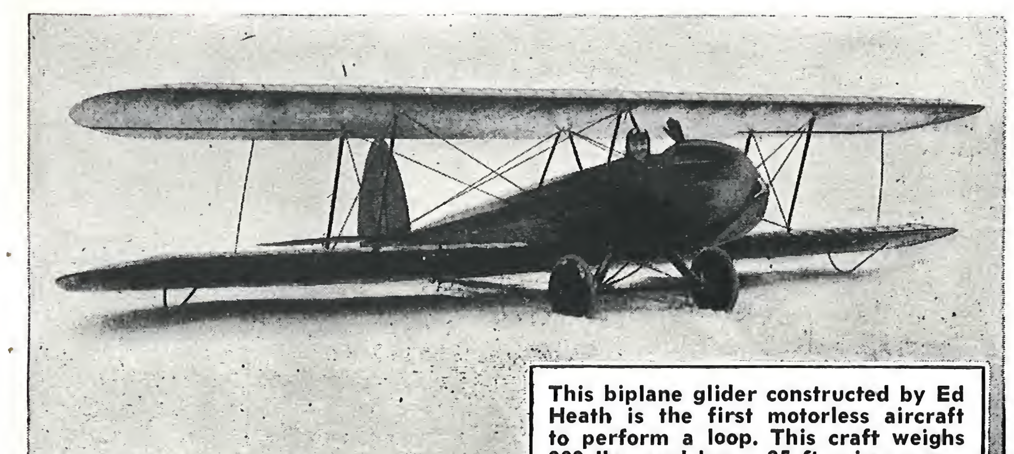
Here are the parts listed in Figs. 5 and 6:

1, rear wing beam fitting; 2, front wing beam fitting; 3, air scoop for cooling rear cylinders; 4, gasoline lines from wing tanks; 5, rudder pedals; 6, rudder control cables; 7, altimeter; 8, oil gauge; 9, tachometer; 10, gasoline throttle; 11, choke; 12, ignition switch; 13, turtleback; 14, wing butt socket; 15, seat bottom minus cushion; 16, headrest pad; 17, windshield integral with top fuselage cowl; 18, hole through windshield for aileron control cable between top horns of aileron. •••

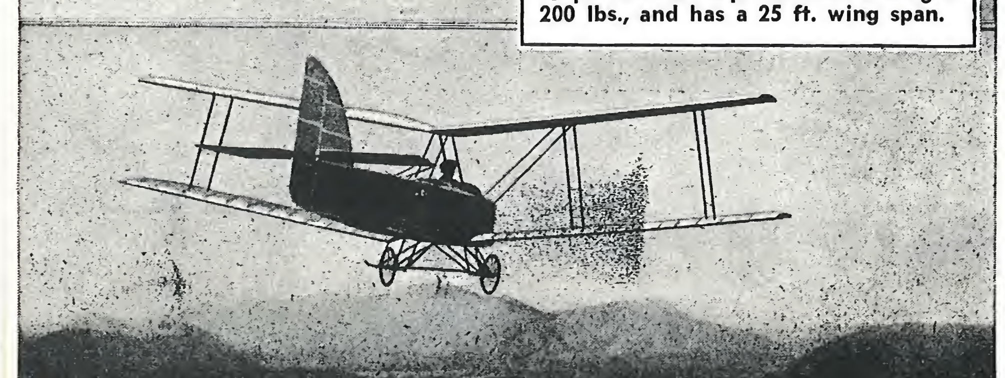


Sound design and clean lines make the Church Mid-Wing a fine performer. Draws the crowds at every airport you land at, too!

BIPLANE GLIDERS ARE POPULAR TOO!



This biplane glider constructed by Ed Heath is the first motorless aircraft to perform a loop. This craft weighs 200 lbs., and has a 25 ft. wing span.



Another type of biplane glider in which H. P. Hentzen, a young student of the Hanover Technical School of Germany made a flight of 3 hours and 10 minutes.

The two Cleveland winners, both landplanes, were converted to seaplanes. Perfect performers, both, they can be put through any stunt in the book.

We asked Ed Heath, America's foremost lightplane designer and builder, to answer the question so often put to us, "Will a Parasol fly with floats?" He did! And in this complete Flying Manual *how-to-build, Stewart Rouse gives every detail!*

By Stewart Rouse
Modern Mechanics' Flying Artist

There had been great activity in the engineering department of the Heath Airplane Company factory for several months, and now the center of this earnest effort was a rakish little "Super Parasol" sportplane which sat poised in spider-like grace upon a pair of silvery 9 ft. pontoons. It was Ed Heath's best answer to the oft-asked question, "Can a practical seaplane be built which a Heath-Henderson motor can fly?" Well, it looked as if the little motor would have plenty to do this time, for the floats looked pretty large to me. As a land plane the ship had been fine, I had seen it fly, and I knew that it had carried its bold racing number 46 to a victory in the lightplane races of the 1929 National Air Races at Cleveland, while its sister ship, another "Super Parasol", took second place in the same event; though neither plane was a special racing job but both were stock "Super Parasols."

As these thoughts ran through my mind Ed Heath strolled over to where I was talking to Claire Linsted, the genial and brainy man who had charge of the men who put the pontoons together, and Ed said that it was quite a hard problem to design pontoons that the man of average skill could build in his home shop, but that he had succeeded very well. As the pontoon gear weighed only 40 lbs. more than the regular landing gear he had no doubt that it would fly very well.

The pontoons are 9 ft. 3 in. long, 12 in. deep, and 16 in. wide. They are spaced parallel to each other and their center lines are 4 ft. apart. Each pontoon has a skeleton of 5/8 in. by 5/8 in. spruce longerons and struts, and is covered with waterproof plywood held in place by small brass wood screws and casein glue. The entire structure is neatly covered with genuine linen fabric doped on with standard aircraft wing dope. A step is built into each pontoon about one-third of its length from the stern, with two 1 in. vent tubes feeding air to the partial vacuum which exists behind the step when the pontoon is in swift motion. The admission of air to this partial vacuum makes higher speeds possible and also helps the plane to break the seal between the bottom of the pontoons and the water. In fact, some seaplanes without vented steps have great difficulty in breaking away from the water unless it is quite choppy. As long as the "Seaplane Parasol" taxies over the water, air rushes down the vent tubes to the steps. The four struts of the pontooon gear attach to the regular landing gear wire pulls permanently attached to the bottom of the fuselage.

On the try-out week weather was rotten, with fog almost daily and a couple of big wind storms thrown in. The "Seaplane Parasol" had been taken to Lake Zurich, which is 24 miles northwest of Chicago, for its trial. This lake is an oval expanse of water surrounded on all sides by small hills which have been eroded away by natural forces until a large part of its circumference is composed of little

er has reached the greatest height at which it can fly with any given length of rope, the eagle-beak is designed to drop the rope at the moment the peak altitude is reached. The slip knot was to be cast off at a jerk in case of emergency.

A wag of the arms from Shank, seated in the cockpit, signified all was set. I put the car into gear and headed for the south end of the field, 2,000 ft. distant. Emery and Lloyd ran along the wing tips, as the rope tightened, and then faster and faster as I gave the Chrysler the gun. Golly, how that bus can travel in second! I went up to about 30 miles an hour as quickly as I could, and Jim, on the running board, said "She's off!"

All of a sudden I felt the car go easier, and quickly turned off to the up wind side. There, 100 ft. aloft, behind me, and sailing quietly like a great gentle bird, was the gull-faced M-M secondary glider I had designed. She floated to earth presently, and Gene kept her wings level by "flying" her with the ailerons until we could jump from the car and help steady her while he got out. He was all grins from ear to ear, was this famous young flyer.

"She's a pip!" was all he said. Which meant he had done his talking for that week. He acts, he does — he doesn't talk. Three words a week is his limit. "Yes", or "no" is a long speech for him. So we knew she was good, and ding-busted good.

Here is how she was built, and later on I'll tell you more about the fine points of flying her.

You will note that her design is simplicity itself, and here and now a few words will not be amiss to show you the whys and wherefores of her design so that you'll see why contemplated changes in any of the fancy work that goes on her should not be changed. Then, too, I know the eds of this yere sheet will be glad if I forestall any questions.

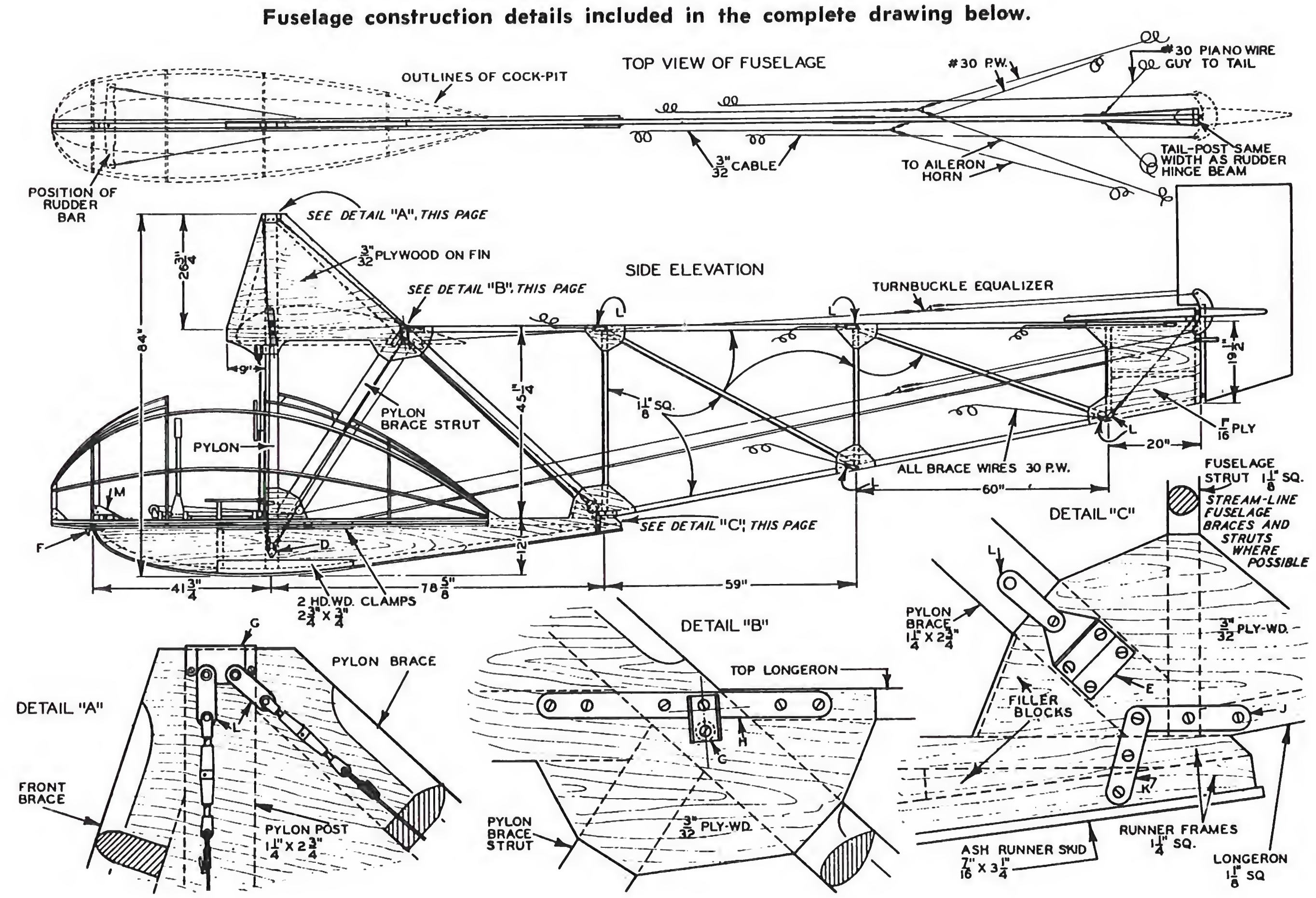
The ship is a secondary glider. That means she is for students a trifle more advanced than the primary glider students. She is more advanced for the simple reason that she is more difficult to fly; you see she is more lightly loaded per foot of surface and per foot of wing span than say, the Northrop Glider, which design was largely drawn upon in making up my ship, for reasons of simplicity more than for anything else.

A secondary ship, being more lightly loaded than a primary type, has different flying characteristics. One of them is the increased tendency to stall. A stalled glider is like a load of "pineapples" in the Hot Place.

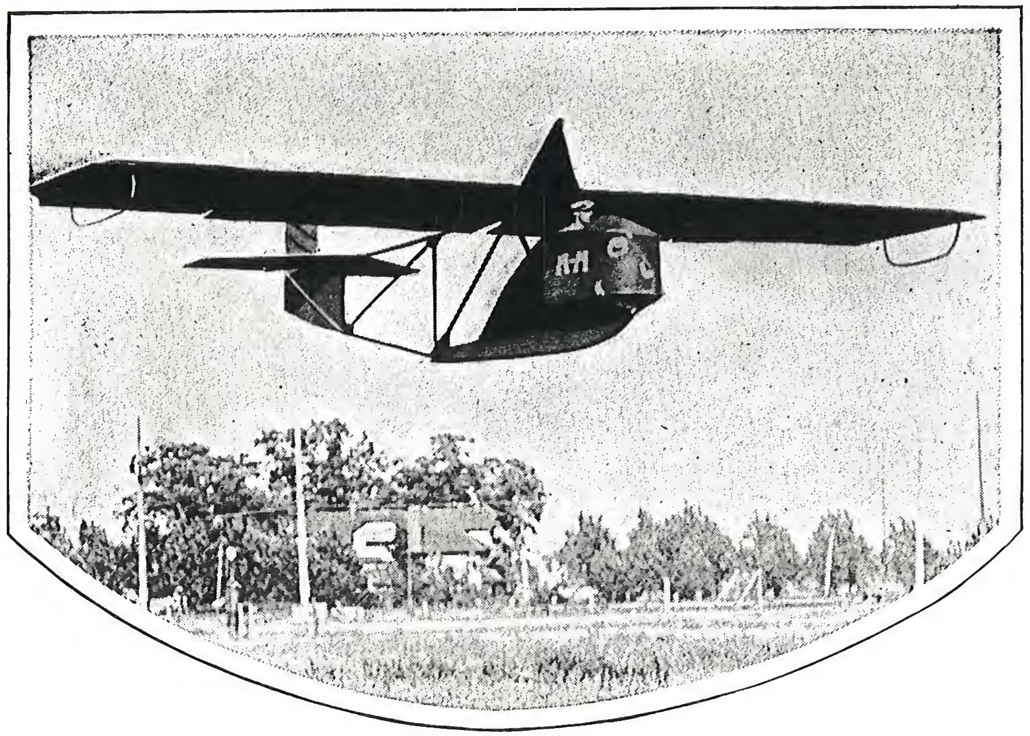
Being lighter, a secondary ship floats more than a primary type, and is more sensitive on the ailerons. It is harder to land, harder to fly, easier to take off. It therefore, you see, requires more skill. It is more fun to fly.

It is just as easy to build. The little cockpit or nacelle is for the purpose of giving much greater aerodynamic efficiency, and is not difficult to build.

Fuselage construction details included in the complete drawing below.



Note how effortlessly the glider seems to float along. This is due to the wing spread, larger than that of primary gliders, which insures a lighter wing loading and makes the craft capable of longer flights.



BUILDING THE M-M SECONDARY GLIDER

By Orville Hickman

What an ideal day it was for the launching and testing of the new M-M Glider! A light wind blew up the field, and for a wonder, in the right direction.

The glider, built to my designs by us fellows at the Robbinsdale Airport, was much heralded. For days little groups of men had gathered about the hangar doors, peering in to see what progress was being made. The ship was ready, but to our dismay we found that unless we had a north and south wind we could not accommodate the car and the rope and the glider.

But at last the wind blew from the right direction. The waiting game over, Gene Shank organized the ground crew. Fresh from flying a Bowlus type glider, he took into account his experiences with that type of machine. I was put at the wheel of Shank's Chrysler roadster, my brother, Emery, and another lad were shown how to run alongside the wing tips until the glider gathered enough speed to make the ailerons effective. This, they were told, would be about ten miles an hour, and they were merely to hold their hands under the wing tips, flat like, until the glider flew off their hands.

A tense air of expectancy hovered about the field. The work of weeks was coming to a crucial test. Would a secondary, or semi-soaring type of glider, capable of staying aloft two or three times as long as the ordinary primary glider, be successful on her first hop?

That's what we were to find out.

At the wheel of the roadster, it was to be my duty to start her off second gear, and keep her there at constant acceleration. This was to avoid the usual jerk attendant upon shifting gears, which is very dangerous on a take-off, because a glider stalls in "nothing flat."

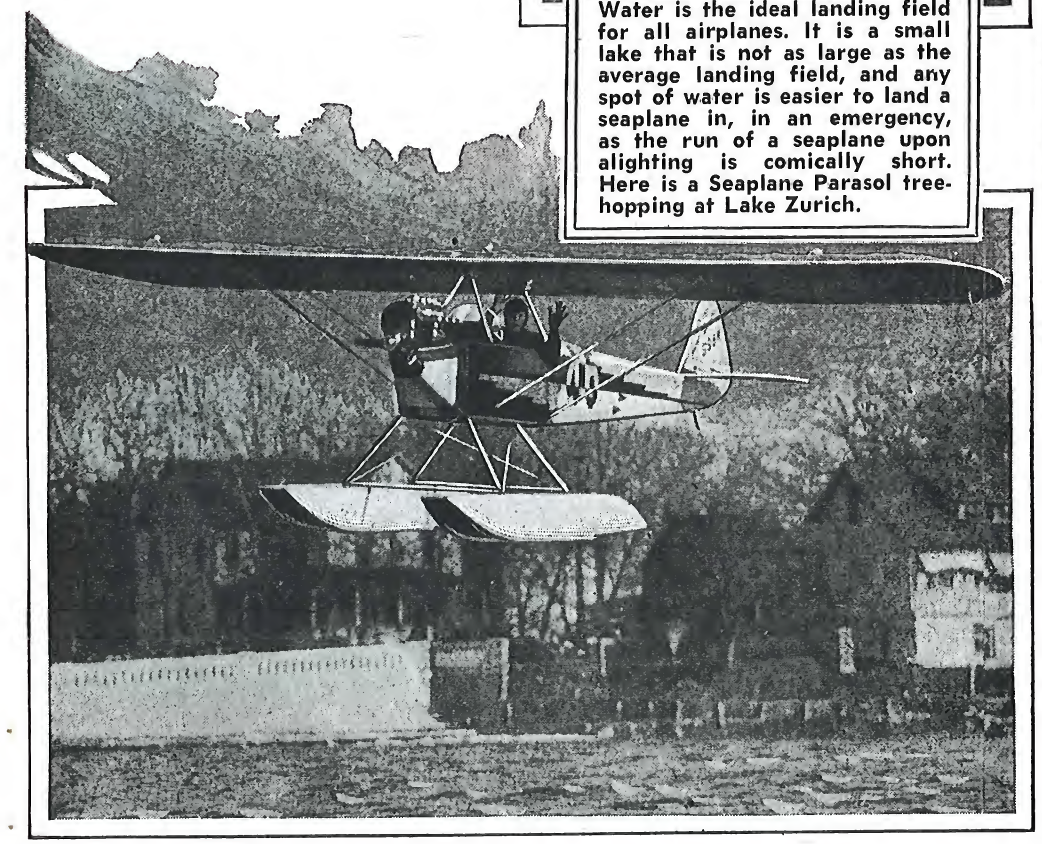
A man accompanied me on the running board. His function was to accurately convey the signals which Shank would wave from the cockpit.

We paid off about 500 ft. of three-eighths manila rope, which was fastened with a readily releasable slip knot to the rear bumper of the car. The other end of the rope fitted loosely in the eagle-beak on the glider. Normally when the glid-

"Parasol" Pontoons

Water is the ideal landing field for all airplanes. It is a small lake that is not as large as the average landing field, and any spot of water is easier to land a seaplane in, in an emergency, as the run of a seaplane upon alighting is comically short. Here is a Seaplane Parasol tree-hopping at Lake Zurich.

Thrilling vertical banks are easily performed above the edge of the lake. This photo was taken from the ground. Ed Heath piloting.



Ed Heath flips the Parasol Seaplane across the Lake Zurich down-draft. The plane controls perfectly, climbs at 450 feet per minute, and can be flown out of lakes less than a mile long.

cliffs. There is dense forest all around the rim and there are small camps and summer cottages everywhere. The lake is about one mile long, and would be an impossible place for a full-sized seaplane to operate from. There is always a devilish downdraft where the wind whips down over the edge of such a cup-like lake, and to fly safely in such a place a seaplane has to have quick take-off and climb extraordinarily fast to be safely above the downdraft by the time the windward edge is reached during take-off. On account of the bad weather the test flight was delayed until Saturday, October 12. It was a very foggy day but it cleared a little in the afternoon and Heath decided to make the test flight then. It was still so foggy that the mechanics could only see the little seaplane now and then, but it flew great, and Ed flew all over the lake at an altitude of about 12 ft. After the bunch got home from Lake Zurich Ed telephoned me asking me to come out to the lake and see some big flying done

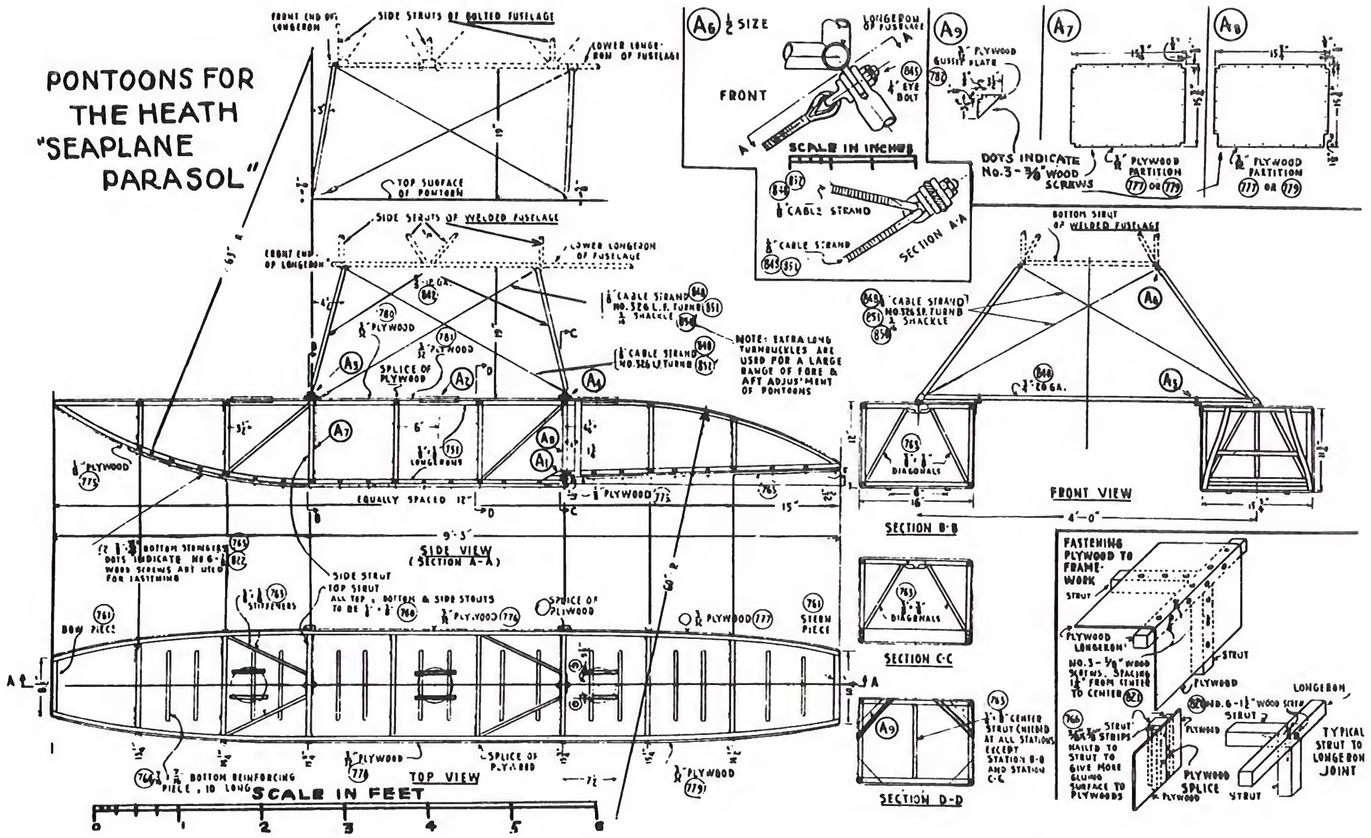
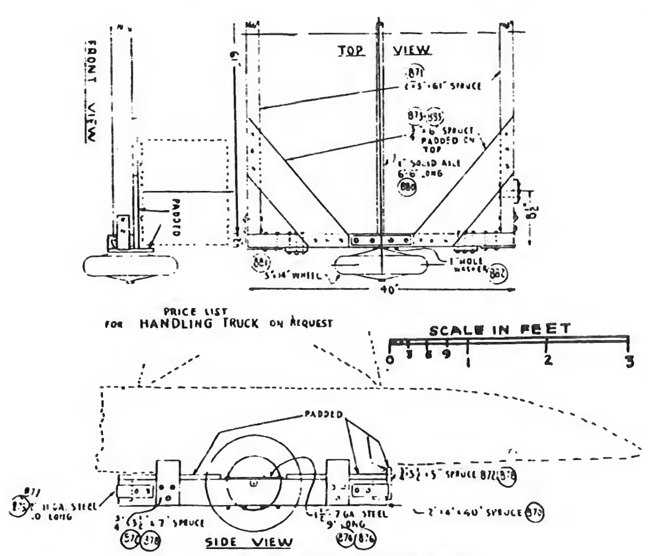


Fig. 3 shows layout and major dimensions of Heath Parasol floats

in a little ship!

Sunday, October 13, was one of those almost too fine fall days we like so well, but which usually happen during the week when we cannot enjoy them on account of our work. I drove through the pleasant little town of Lake Zurich on top of its little hill, and on down the curving white road through the autumn-hued trees to the shimmering



HANDLING TRUCK FOR THE HEATH "SEAPLANE PARASOL"

This is figure 5 and shows the details for the light handling truck which is used to handle the floats ashore. Light floats must not be left to soak up weight. See page 53 for details.

lake, where I saw Ed's gang grouped on a narrow strip of beach near a boat landing. I went down to the beach just in time to see Ed taxi the "Seaplane Parasol" in from a landing. Claire Linsted, in glistening black hip boots, pushed the neat little handling truck under the pontoon steps, then Heath gunned the motor a little and ran right up on the beach while Claire held the tail skid with his left hand. That part worked fine. A huge crowd of motorists gathered, but were not much trouble to us as they are when one is flying a land plane for they cannot get in the way, as they can't run around on the water like they can on a field.

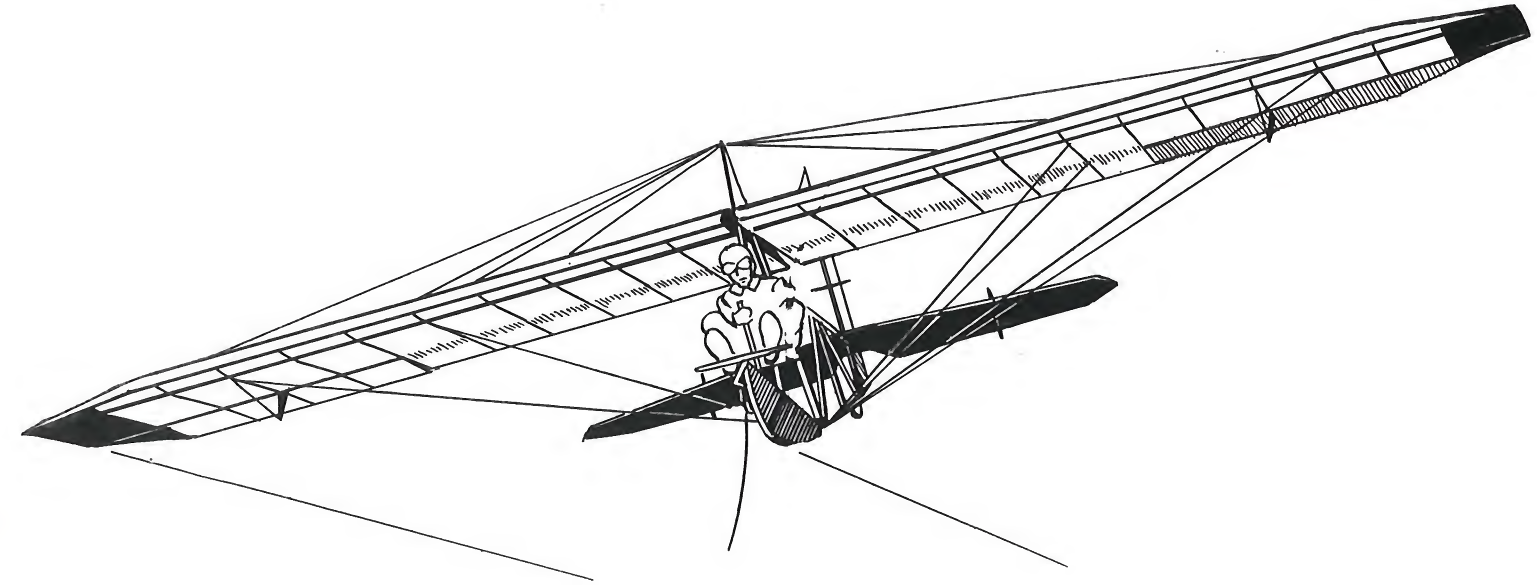
We all wanted to see the business-like appearing little seaplane fly, so Ed (who can't swim a stroke) let them give him a push out into the lake while he stood on the left pontoon. From a position just in front of the left front flying strut he flipped the propeller with his left hand. The Heath-Henderson motor took hold instantly and idled nicely, while Ed turned and climbed into the cockpit.

Without hesitation he headed the "Seaplane Parasol" into the cool north breeze as the little plane got up on the step and stepped!

The man with a stop watch, standing beside me, said that this take-off took eight seconds.

"Not bad," thought I, "when you consider that one famous maker of 300 hp land planes is proud of their 12 second take-offs!"

The little seaplane began to climb at about 450 feet per minute and long before Ed reached the downdraft, five-sixths of a mile away, he was



BUILDING A GLIDER

Glider clubs have sprung up in all parts of the country in such numbers that it is safe to say that the sport of gliding has come to stay. Gliding is, of course, more than a sport. It is a safe and excellent method of flying training, especially when the beginner is under the supervision of a competent instructor while he is gaining his experience.

What is the best way of getting into the sport of gliding? Obviously the first requisite is to secure a glider, which may either be bought or built in one's home workshop. In the pages which follow are presented complete plans for an excellent glider which combines features common to several types. The working drawings are so complete and the directions so specific that any competent craftsman can duplicate the ship without difficulty.

Gliders are of three types. The first, or primary type, has no enclosed fuselage. The Germans, to whom the development of the modern glider must be credited, call this type the "Zoegling." It consists of wing and tail surfaces supported by an uncovered fuselage, and the pilot sits out in the open on the nose of the craft. Control is effected by stick and rudder bar, just as in the conventional airplane.

The secondary type differs from the first mainly in having its fuselage covered with fabric and carefully streamlined, with a cockpit provided for the pilot. This is known to the Germans as the "Prueffling."

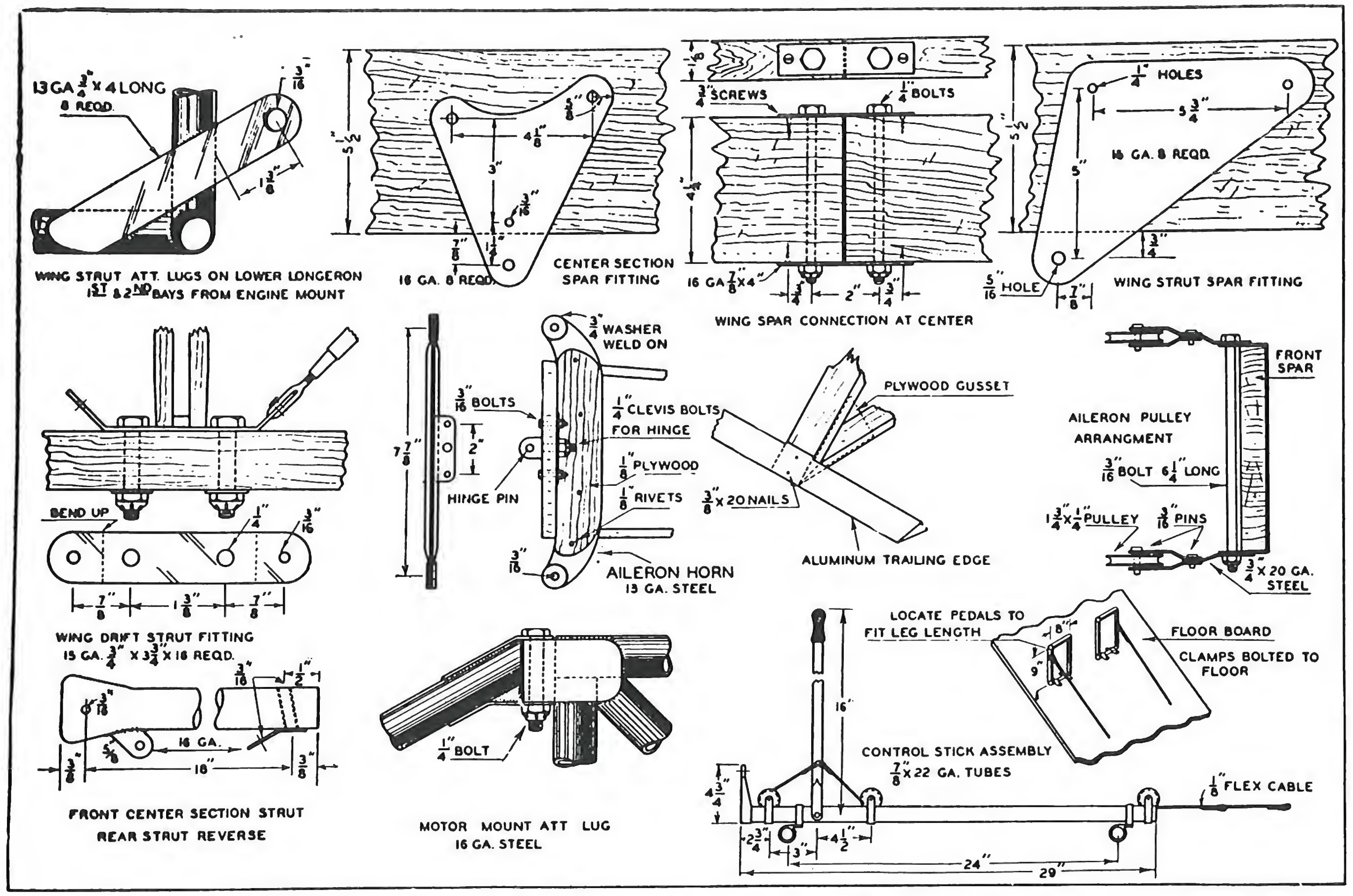
The third type is known as the soaring glider, and is for the use of advanced students with sufficient knowledge of flying to take care of themselves in any emergency. It is extremely light and has a very wide wing spread. Such gliders, sometimes described as sailplanes, hold the records for distance and endurance flights.

The M-M secondary glider, presented herewith, is built sturdily enough to resist the hard usage to which beginners in the sport are likely to subject it.

In building a glider, bear in mind that there is nothing supernatural or mysterious about motorless flight. A glider is an extremely simple piece of mechanism. There are no gas throttles, oil gauges, clutches, and brakes to confuse the pilot — nothing but a rudder bar and control stick. Glider flying is not fool-proof — neither is anything else. But a glider carefully built from good plans, such as follow this page, affords a safe medium of getting into the air.

Don't try to loop the loop with the M-M glider, after the manner in which Ed Heath describes his feat on another page of this Manual. Don't pull the nose of the glider up in a stall. A glider is designed to *glide*, and if you bear this in mind you'll avoid the main cause of glider accidents. All gliders, especially primary gliders, are so ruggedly constructed in proportion to their weight that they resist the hardest usage. The shock of an airplane coming to the ground for a landing is much greater than that of a glider, which skims along the earth and settles down as gracefully as a bird. The landing speed, naturally, is much less than that of an airplane.

There are hours of good red-blooded fun in store for builders of the M-M glider, and if these pilots care to go on and learn to fly a powered airplane — and most of them will — they'll find that their glider experience has been invaluable.



This sheet covers all the necessary details for building the Georgias

and tight, but do not crush the wood fibers by getting *too* tight.

Wing Tips

The wing tip is elliptical in form and ½ in. steel tubing is used to form this curve. It is attached to the leading edge, spars, and aileron attachment spar by strips of copper. Nail and solder the nail heads to the copper strip.

Wing Struts

They are made up of 1 in. by 20 gauge seamless steel tubing and streamlined with spruce and taped. Then dope them. They are adjustable on one end for rigging purposes.

Assembling

In assembling this ship, first put on the tail surfaces and be sure that they are bolted and all nuts cottered, then put the control wires in and determine where the wires will come out of the fuselage covering so that you can put little leather patches where they come through.

Covering of the Ship

This procedure is carried out as an envelope method wherever possible and the open edges hand sewed. Five coats of dope clear are used and pigment color that the builder desires. The wings should be sewed before they are doped, every 4 in. between the spars and around the ribs. After the first coat of dope the ribs must be taped over and the leading edge and the trailing edge, control surfaces are taped over each rib, but it is not necessary to sew the cloth to the ribs in this small plane.

Balancing the Plane

To correctly balance the plane put the fuselage with all parts assembled on a knife edge made from a 2 by 4 with the weight of the pilot in the cockpit and gas and oil in the motor, then place the wing by rigging the center section struts until the center of lift comes right over the place that the plane balances. In the Clark "Y" airfoil the center of lift is 42 percent from the leading edge. The bottom part of the airfoil must be level with the top longeron as the wing curve is set at "0" degrees for the best efficiency.

Then be sure that the wings are exact laterally — this ship should be flown without any dihedral, and the wash-in on the wing tips will best be determined by flight. Adjust until the ship will fly hands-off and have no tendency to fall off on one wing or the other. • • •

high enough to turn and follow the shore of Lake Zurich, flying back over the town on the hill just above its house tops. He then glided down along the edge of the lake and over us, where he flew back and forth with his engine throttled back, actually *soaring* on the updraft, for the engine was ticking away too slowly to do any pulling. Ed says that on a windy day one can soar for hours on the updraft along the wooded edge of a lake or wide river, and he points with pride to the fact that to make a forced or voluntary landing one has only to turn toward the lake or wide river and land directly against the wind, the ideal and only really safe way to land.

Soaring is simple in theory, the updraft of air simply goes up faster than the gliding angle of the plane brings it down, result, the plane just doesn't come down. Hedge-hopping around in a land plane is one of the greatest pleasures in flying but is dangerous, for if the motor stops when the plane is close down over ground unsuitable for landing, a crash is usually the result. Flying low around the edge of a lake has all the thrill of hedge-hopping a land plane, but if the motor conks, "Nature's Airdrome", as Ed calls it, is always there to welcome the pontoons of your seaplane to a soft landing on its waves.

Heath calls attention to the fact that the fields a land plane rely on are often as small as 10 acres, while any little lake boasts 100 to 1,000 acres of ideal level airdrome surface, and large rivers cross the country for hundreds of miles, providing a landing all the way. In other words, seaplanes are pretty good airplanes, though somewhat neglected at present. But we must get back to Ed; we left him soaring over our heads, you know, and he continued

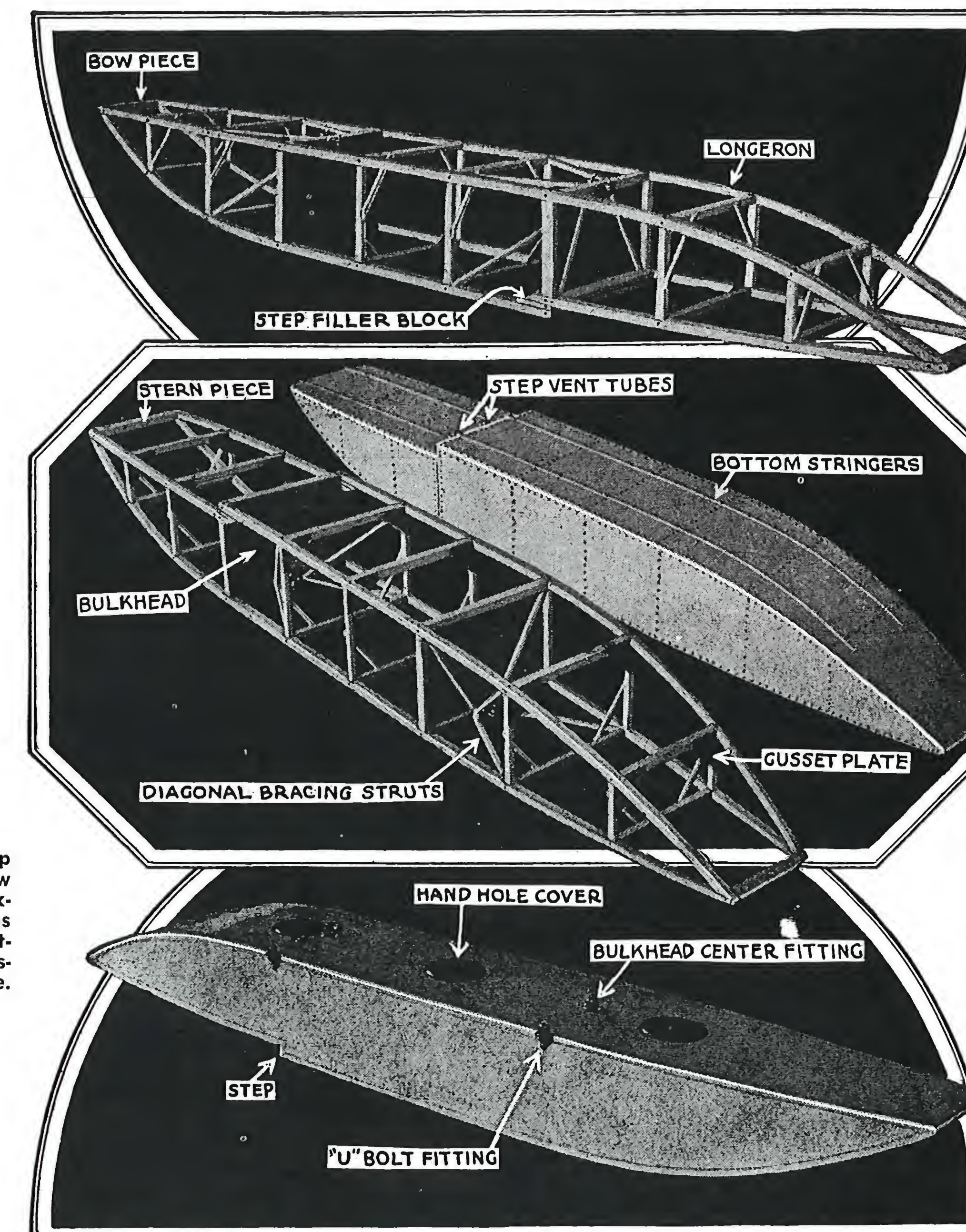


Figure 2. This step-by-step series of photos shows how the pontoon frames, bulkheads and fittings look as the work progresses. The bottom stringers prevent bruising while handling on shore.

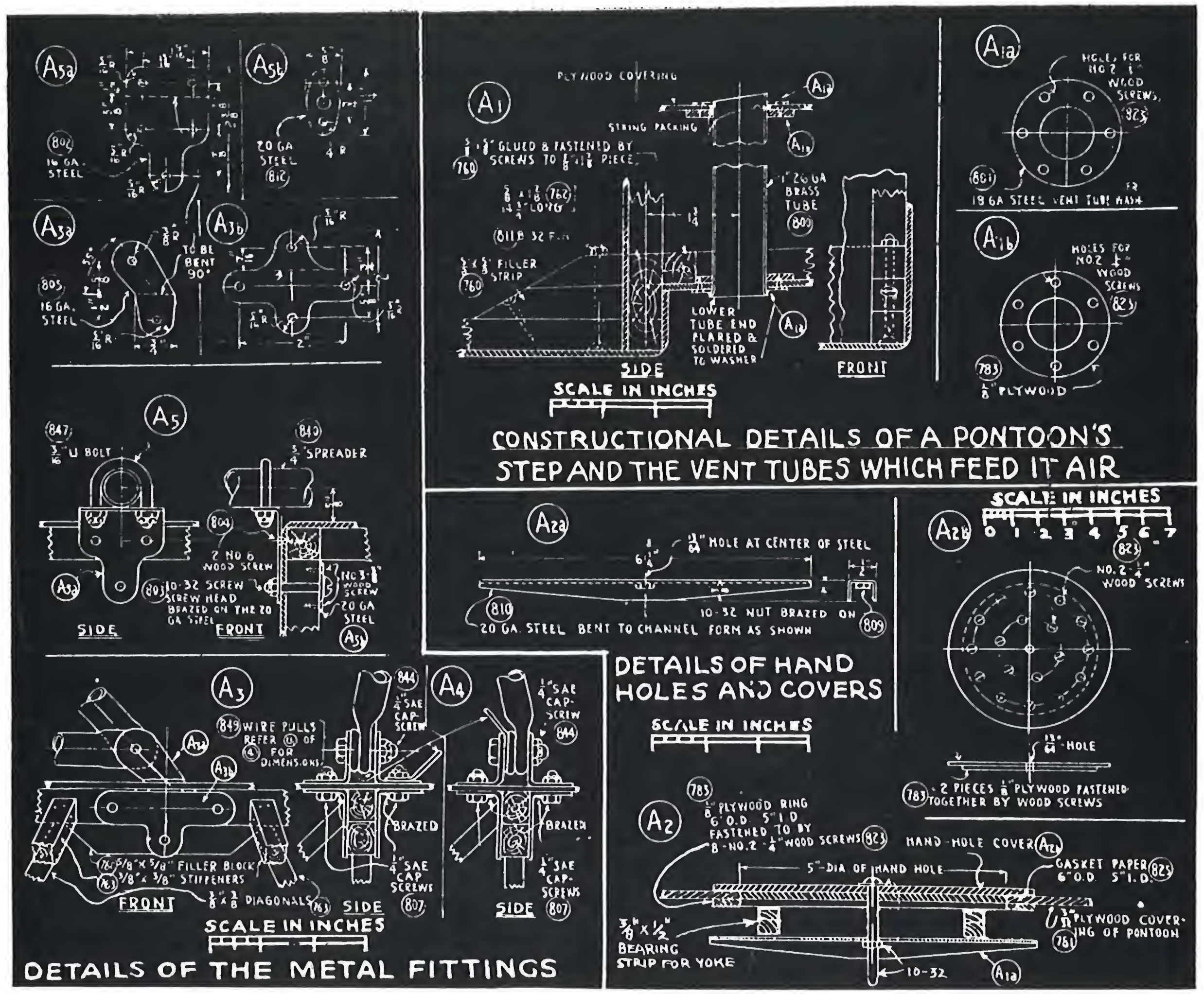


Figure 4. This shows the metal fittings and the detail of the step construction. The handhole plates, of plywood, are sealed as shown. Full details for the step vent tubes are given in the text.

this for about 20 minutes. During the flight which lasted about 50 minutes, Heath put the "Seaplane Parasol" through a number of difficult evolutions including some vertical banks close to the ground, a few turns of a spin, and a lot of deft wing-overs. The soaring Heath did was what impressed me most though, because it proves that the little seaplane is *not* heavily loaded with pontoons. It flies about like the land plane version of the "Super Parasol" and looks very impressive in the air. In fact, when it flies overhead at a good altitude, it is hard to convince oneself that it is not a 300 hp cabin seaplane, for its proportions make it look like a big ship. After this very peppy flight Ed front-slipped in for a real hot landing right in front of the crowd. Duke Muller, Heath's factory foreman, and a photographer had been cavorting around the lake like a couple of young sea gods in an outboard speedboat taking pictures of the "Seaplane Parasol" in action with a Graflex camera. These pictures illustrate part of this article.

One man can handle the "Seaplane Parasol" without aid and without getting his feet wet. When Ed Heath's mother, in California, received a letter from a friend saying that Ed was about to test fly a new seaplane, she wrote a letter to her son Ed in which she cautioned him against getting his feet wet and advising him to wear a pair of rubbers! Aviation has certainly gotten beyond the daredevil stage!

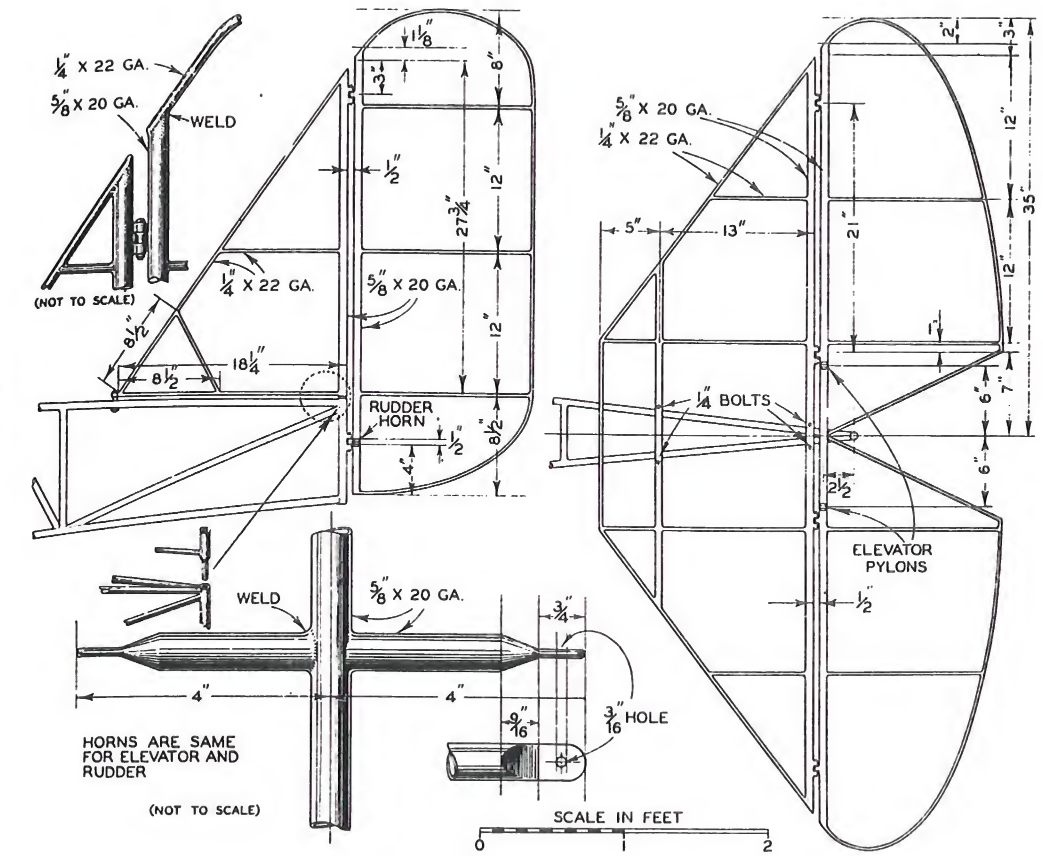
Small seaplanes such as the "Seaplane Parasol" are the only airplanes that can be used in the large areas of timber country with their abundance of small lakes.

The "Seaplane Parasol" is without doubt the smallest, lowest-powered, successful seaplane in the world. When Heath was flying at an altitude of 2,000 ft. over Lake Zurich he could count 21 small lakes within gliding range, any of which would have served as a landing spot, for a landing can be made on a couple of acres of water since the landing run of a seaplane is comically short.

A man of average skill should have no difficulty in building and flying a "Seaplane Parasol." He can easily build the pontoon gear according to the following description and directions.

First, study the photos and drawings which illustrate this article to gain a clear conception of the complete pontoon gear. When you have familiarized yourself as well as possible with all the parts

Orville Hickman, author of this article, tells how to manipulate the fine tubing so that it will not bend or warp. Notice how the horns are made. Simple, eh?



is determined from the wing profile that you laid out on the rib jig. Secure this to the ribs with 3/8 in. by 3/8 in. wooden blocks, glued, and lots of small nails.

Trailing Edge

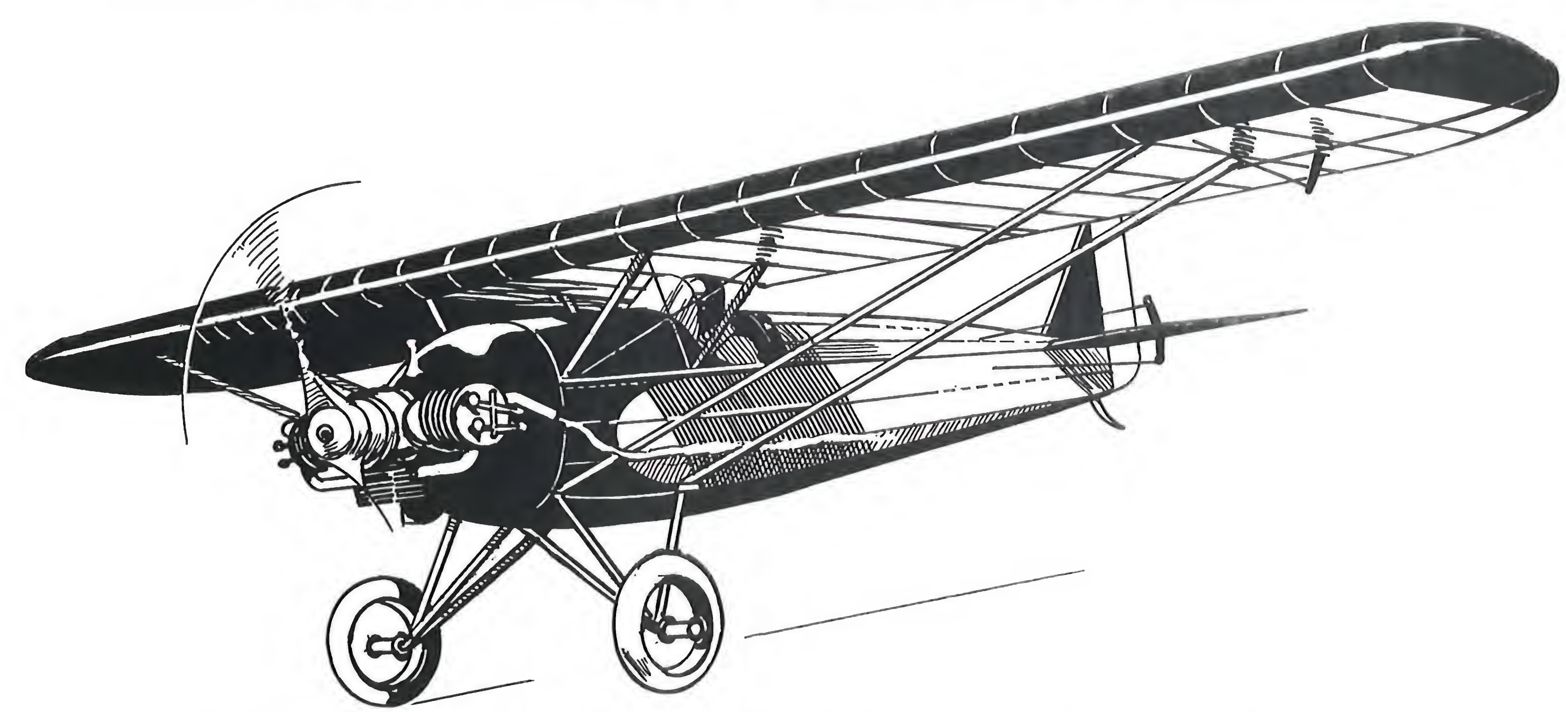
This is made of a two-inch piece of 24 gauge aluminum, nailed after it is formed, into a "V" shape onto the tips of the ribs.

Aileron Control Pulleys

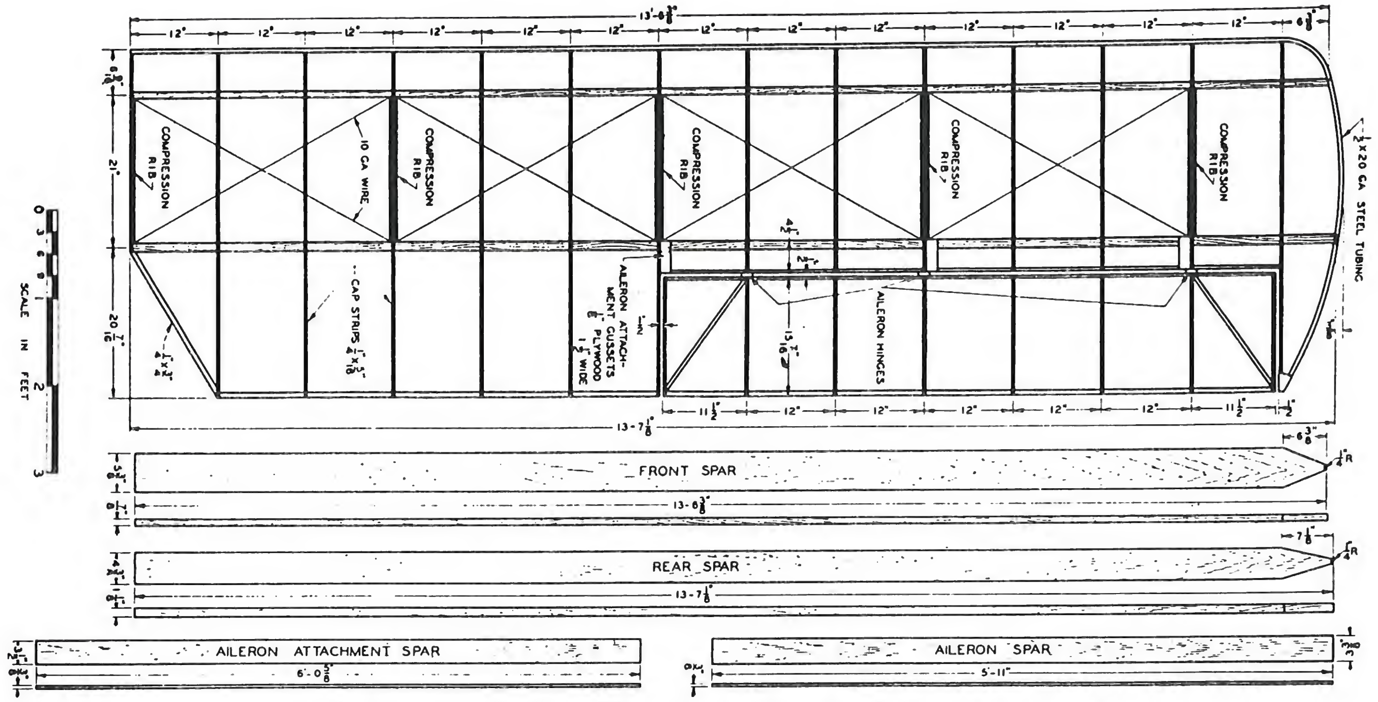
These are secured at their respective places as shown on the drawings.

Aileron Horn

This is made up as shown by drawing. Care should be used to get the attachment bolts good



In action the Georgias Special is reminiscent of the new Boeing high wing fighter. It flies strongly with the Lawrence, providing the motor is turning up properly, and the standard Lang prop is used.



This very clear drawing will enable one to build all the details needed for a successful wing panel. Note the method of aileron placing.

cutting of the aluminum. There is no beating to be done on this cowling. The fuselage cowling can be cut from one piece and the cockpit cut out in its proper place. The motor cowling is in one piece on the bottom and two on top, bolted together with 3/16 in. stove bolts.

Ribs

You will see that the ribs are made from pieces of 1/4 in. by 5/16 in. spruce, fastened together with airplane glue and 3/8 in. by 20 gauge flat head nails. Use 1/16 gusset plates; these gusset plates are best determined in size by the place they go. The outline of the rib should be placed on a smooth piece of board and outline caps placed so as to hold the form of the rib when nailing the gussets, also all of the internal bracing of the wing should be outlined with outline caps so as to hold the bracing while being glued and nailed. After the one side is glued and nailed take out of the jig and turn over and glue and nail the gusset on that side.

The Wing Beams

These are made intentionally solid. For the amateur, "I" beams are a little too difficult and often the professional makes mistakes with them; therefore, solid beams of the best selected spruce must be clear grained, no knots, pitch pockets, and straight grained, with at least 10 annular rings to the inch.

Cut the beams very carefully, follow the drawings, and you cannot go wrong. It is best to cut the beams just a little large and then plane down to right size, making sure not to get them too little as that is the first step to heaven.

Aileron Attachment Beam and Aileron Beam

These are made solid. Follow very carefully drawings of same. Mortise the aileron attachment beam for the ribs and place the safety plywood gussets as per drawing. Securely glue and nail these attachment ribs and gussets. Use 3/4 in. by 20 gauge flat head nails, for this, also for attaching the rib ends to aileron attachment spar.

The aileron spar is built the same way by mortising the ribs into the beam and gluing and nailing with 3/4 in. by 20 gauge flat head nails, and placing little triangular spruce pieces glued, together with nails on each side of the aileron rib at its attachment to the spar.

The aileron is made up very easily. It consists of the aileron spar and ribs cut off of the regular ribs at the aileron space. A trailing edge of aluminum shaped in a "V" shape is slipped over the ends of the ribs. Be sure that the aileron lines up when the hinges are placed on, and that the trailing edge of the aileron is in line with the wing. A web of 1/8 in. plywood is applied to the inner end rib of the aileron and to the adjacent end of the common rib at the inner end of the aileron opening in the wing.

Internal Wood Bracing of Wings

Three-eighths inch by 3/8 in. wood braces are applied inside the wings as shown in the drawings. First the wooden blocks are nailed and glued to the members to be united by a brace, then the brace is nailed and glued both to blocks and the members to be joined together.

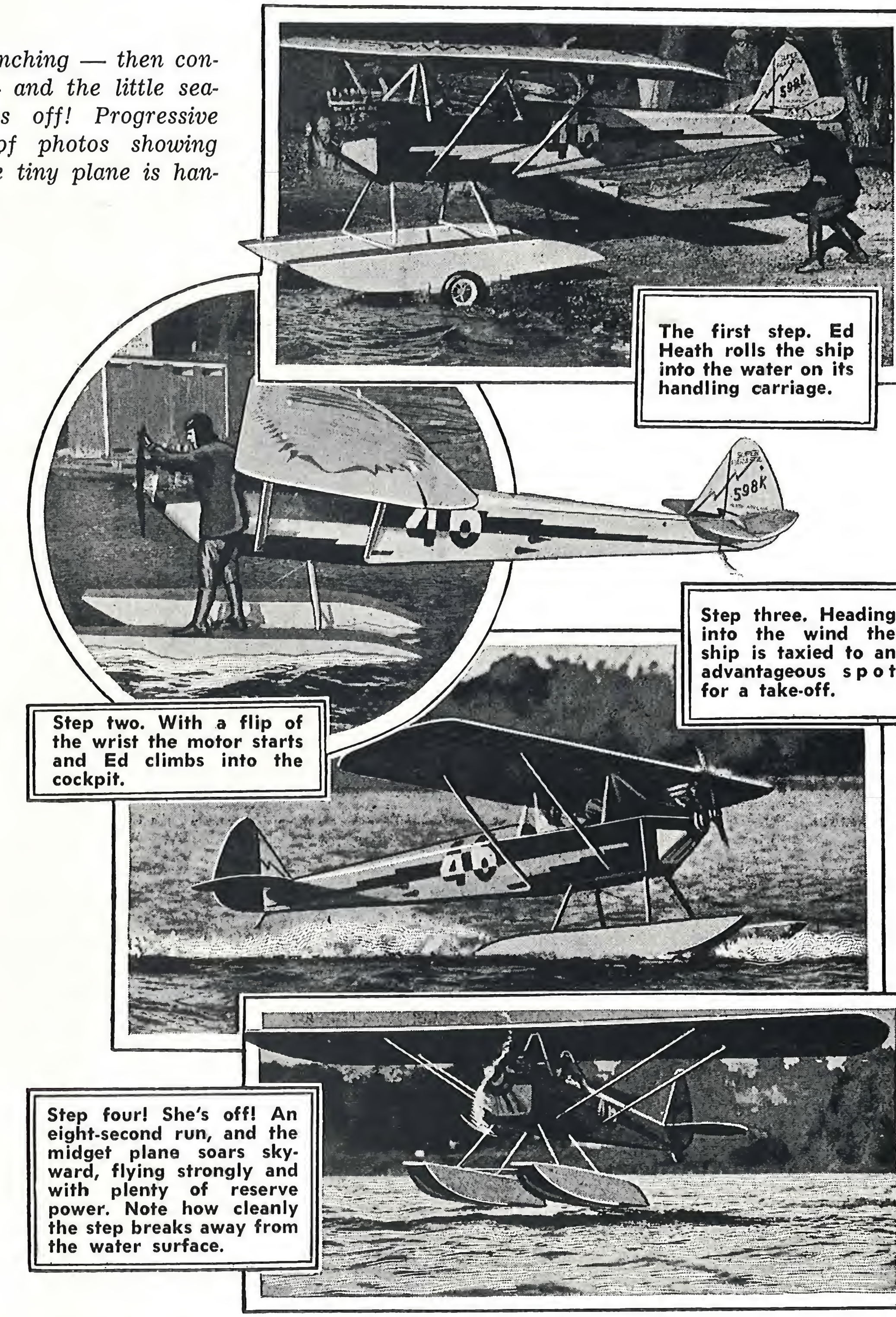
Compression Struts

These are pieces of 3/8 in. by 3/4 in. spruce nailed on each side of the regular rib, also glued at each place, and nailed. You will need 10 of these and 18 regular ribs.

Leading Edge

This is made of a piece of 1 1/2 in. by 1 1/2 in. spruce 13 ft. long, planed to required size which

The launching — then contact! — and the little seaplane is off! Progressive series of photos showing how the tiny plane is handled.



The first step. Ed Heath rolls the ship into the water on its handling carriage.

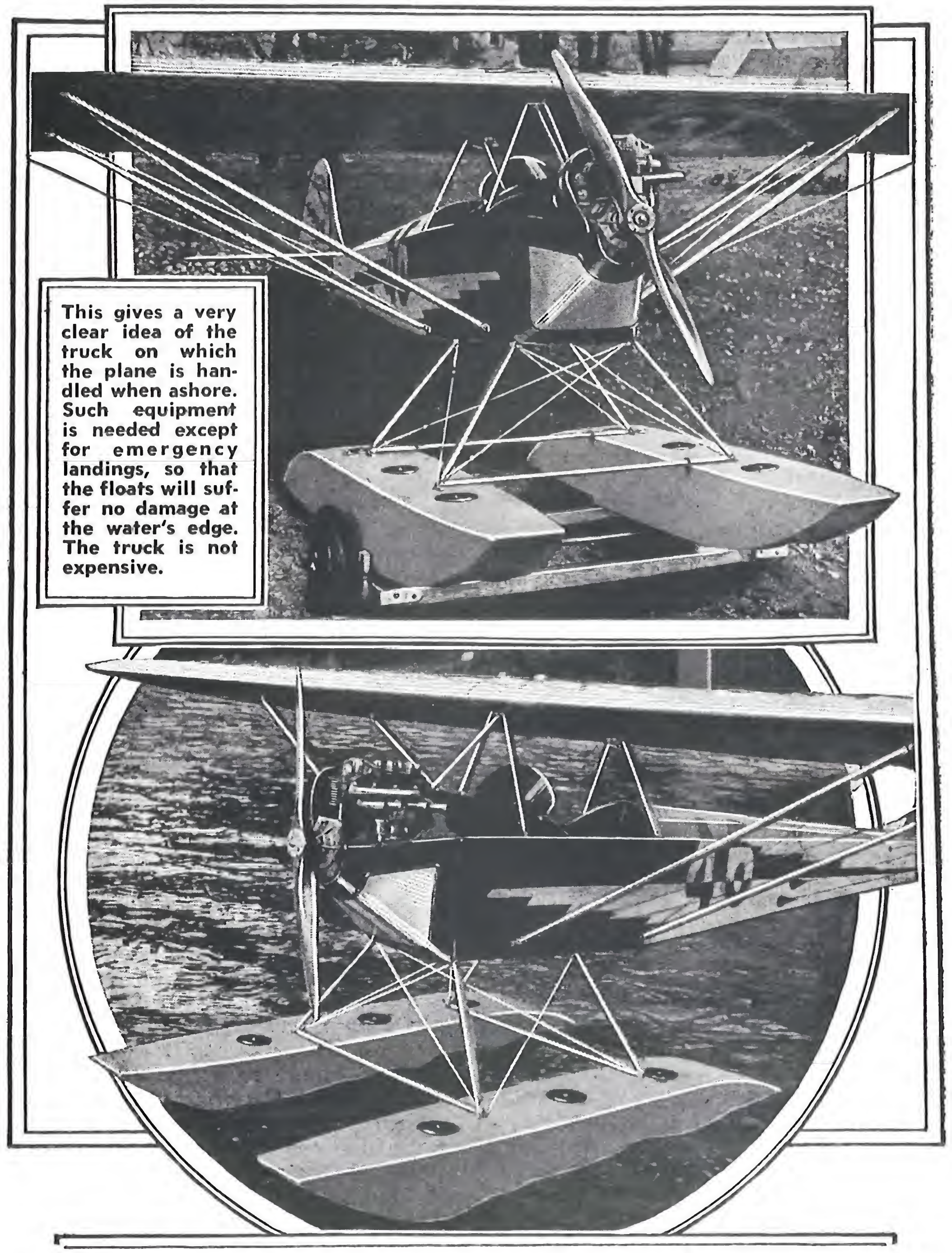
Step two. With a flip of the wrist the motor starts and Ed climbs into the cockpit.

Step three. Heading into the wind the ship is taxied to an advantageous spot for a take-off.

Step four! She's off! An eight-second run, and the midget plane soars skyward, flying strongly and with plenty of reserve power. Note how cleanly the step breaks away from the water surface.

shown in the drawings you will be ready to read the rest of this article.

It is first necessary to make a jig in which to assemble the side panels of a pontoon's framework. On a strip of heavy brown paper about 18 in. wide and 10 ft. long, draw the accurate full-size plan of the side view of the pontoon's framework, scaling it from the drawing, see Fig. 3, page 50, showing the top and bottom longerons and vertical struts as heavy, double, pencil lines 5/8 in. apart. The upward front, or bow curve of the bottom longeron is drawn with a 63 in. radius, with a point on the extended center line of the third side strut from the bow as a center. This center point is, of course, 63 in. from the bottom of the bottom float longeron. The downward, rear, or stern curve of the top longeron is drawn with a 60 in. radius, using a point 60 in. below the top of the top longeron, and 7 1/2 in. to the rear of the extended center line of the third side strut from the stern as a center. Use a pencil, string, and a small nail for a compass in drawing these curves. Draw the step very carefully, con-



This gives a very clear idea of the truck on which the plane is handled when ashore. Such equipment is needed except for emergency landings, so that the floats will suffer no damage at the water's edge. The truck is not expensive.

Midget seaplane can cruise skies everywhere with comparative safety.

Using the wheels from the landplane on a truck of simple construction the plane can be easily handled by one man. Note the float handholes for pumping the floats dry and for inspection.

sulting the drawing of the step, A-1 in Fig. 4. When the drawing is completed, tack it smoothly to a smooth floor, with enough room all around it to permit working freely. To make the jig, make up a lot of small pine blocks, 5/8 in. by 5/8 in. by 1 1/2 in. in size, and nail them in pairs, one on each side of the double longeron and strut lines of the drawing, at points midway between strut points, to make a jig to hold the struts and longerons during assembly. At the curves the pairs of blocks should be spaced somewhat closer together.

Note that the top longeron is made of one piece of 5/8 in. by 5/8 in. airplane spruce about 10 ft. long, while the bottom longeron is made of two pieces of 5/8 in. by 5/8 in. spruce, the front longeron being about 6 ft. 6 in. long and the rear one about 3 ft. 6 in. long. These measurements are somewhat too long in order to allow for fitting of the ends during assembly. The step is made by overlapping the rear bottom longeron on the rear end of the front bottom longeron with a 5/8 in. by 5/8 in. spruce filler block between them to give a 5/8 in. higher step. This joint is made with genuine casein aircraft waterproof glue, and is reinforced by an 8-32 flush head bolt about 2 1/8 in. long, and a No. 6 1 in. wood screw as shown at detail 811 in Fig. 4. A hole the same size as the bolt must first be drilled through the wood parts to be joined, to re-

ing is secured by drilling a small 1/8 in. hole opposite each tubing that the fairing passes and wrapping heavy cord through the hole and around the tubing. This is later doped.

The bottom and top turtle decks are built up and mortised into formers. They are bolted to the longerons and cross bracing by small aluminum clamps that go all the way around the tubing, bolting into the spruce formers.

Seat

This is made from a piece of 16 gauge aluminum secured around the top horizontal bracing of the third bay of the fuselage. A wood former is placed on the floor board. This piece of board is determined by the size of the person who is to fly the ship and a little "self designing" must be used there.

Fire Wall

This is a very important part of the ship so care must be taken in fitting it to the front part of the fuselage. It is built of 18 gauge aluminum and has as small openings as will just let the necessary gas and oil and other necessary instrument accessories through. Right here let me say that the gas and oil lines should have a piece of rubber tubing placed over them where they go through the fire wall so that vibration will not chafe the lines and cut through.

The Landing Gear

The landing gear is the most important part of the ship when you come in to land so must be built with the most exact care. It is best built with the ship leveled up and in the correct distance from the ground. Then the correct diagram placed on the floor directly underneath, the tubes cut and placed in their respective places.

The stub axle as you see from the drawing should be first built up, bent and welded into the false axle which goes up to the top of the gear. The shock cord is attached to the cross member, the gear is reinforced down at the attachment with the stub axle with 16 gauge sheet steel 6 in. up from the stub axle inner washer on both sides.

The wheels can be streamlined if you like with cloth, and doped, but it is not necessary. Use 1/2 in. shock cord. It takes 3 ft. for each side.

Tank

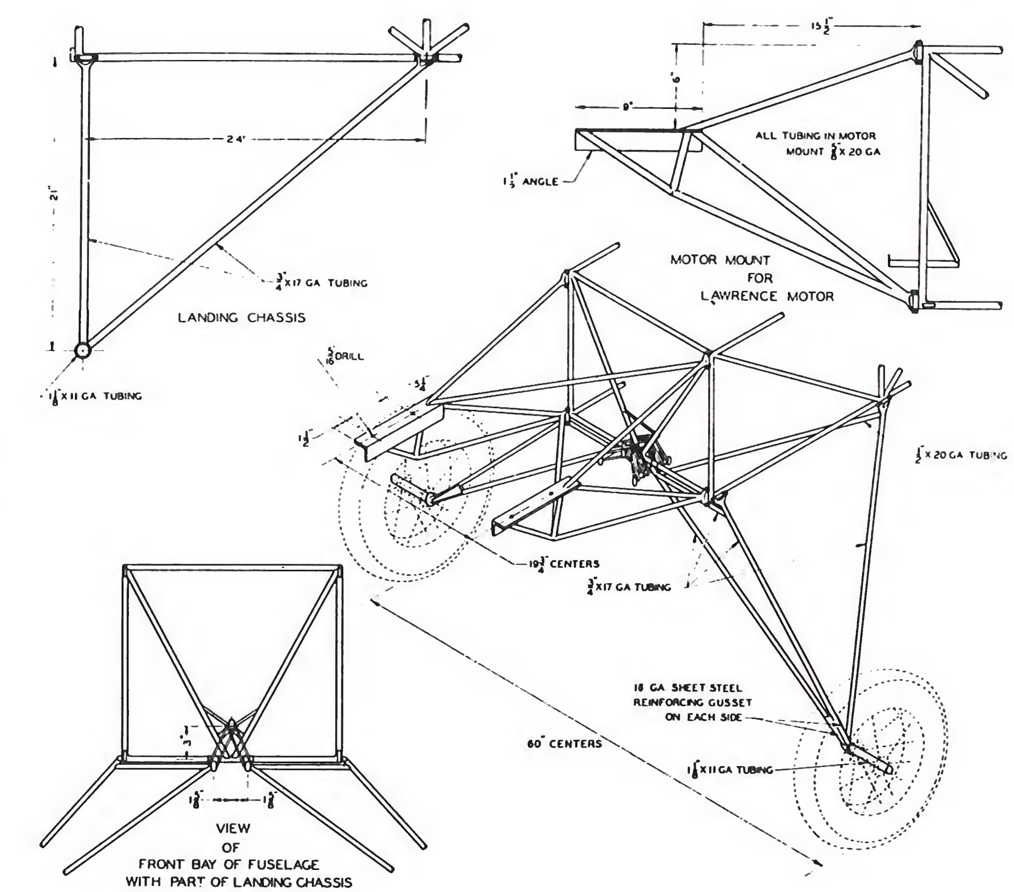
This should be built with tern plate and no dimensions are given, because each person wants a different capacity. Its location is shown. Unless you are very good with a soldering iron and solder, I would advise you get it built by a local tinsmith.

Propeller

This should be bought from some of the propeller companies for best results. A ship has been built from these plans using a 28 hp Lawrence-Hickman conversion.

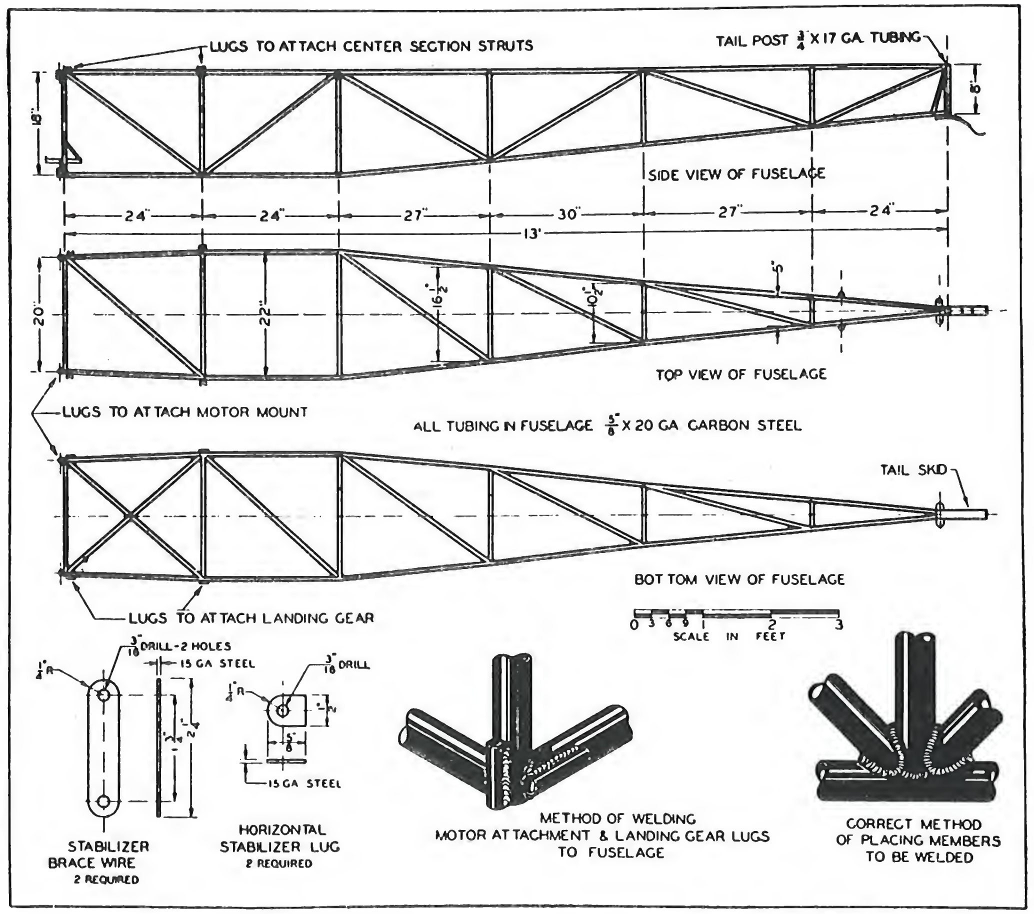
Cowling

This can make or break the looks of the plane, and extra care should be used in making this. A great deal of ingenuity must be used here for the correct lines of the ship depend on the correct



The Cessna type undercarriage is one of the most simple types of landing gear to build, as well as being the easiest of the split types to keep on a ship. The drawing will give you a good idea of how the motor mount is lined up.

Here is a more specific drawing than the one on the preceding page. It shows the side, top and bottom layouts for the fuselage members. Note the manner in which the lugs are welded on.



teen gauge steel tubing. They are welded on the lower longeron at the first and second bay of the fuselage and are securely welded to the longeron in line to the landing gear struts and in reference to the longeron.

Motor Mount

The lugs for the mount are welded to the front end of the longeron and for greater safety are reinforced with a piece of 16 gauge sheet steel passed around the lug and welded to the horizontal tube and the longeron. This mount need not be made demountable unless the builder likes, but in case you do want it this way, cut out the straps which fit over the ends that are to be supporting tubes of the mount and drill the correct size holes; then the mount is bolted to the lugs that were welded there for same. Next lay out the mount on the table and spot it as you did the other metal work, then place each respective half on their respective places and block up and get lined up and spot the cross bracing in place after all of the members are placed in. Then weld up the mount.

Tail Skid

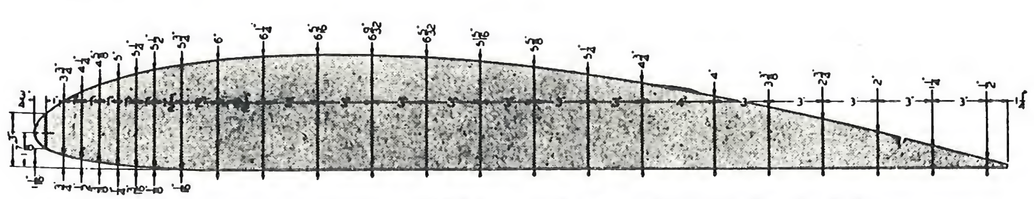
This part of the ship is a small spring that can most generally be secured in a junk yard where there are some old buggies to pick from, but if not procurable there, make one from spring steel 3/16 in. by $1\frac{1}{4}$ in. shaped as shown and placed at the extreme rear part of the lower longerons. The skid is secured to the longerons by two $\frac{1}{4}$ in. N.S. bolts.

Instrument Board

This is made from a piece of plywood $\frac{1}{4}$ in. thick and cut to fit under the cowling. The form should first be secured by cutting a paper pattern, and then using that to cut the correct form on the plywood. Next, the exact size of the holes for the instruments can be cut by an expansion wood bit. The cowling is clamped by small aluminum clips to the vertical and to the horizontal tubing the same way.

Fuselage Fairing

On the side of the fuselage the fuselage fair-



Here is the accurate scaled layout chart for the Clark Y-15 wing used on this ship. These dimensions are taken from the full sized ship and are accurate within close practical limits.

ceive the bolt, and a $\frac{1}{8}$ in. hole must be drilled through the block to receive the screw.

Steam-Bending the Longerons

The longerons have to be steam bent and dried at the curves before being assembled in the jig. This may be accomplished in the following way. Wrap the portions of the longerons to be bent in a heavy bundle of rags, then saturate the rags with water and put the ends of all eight longerons, rags and all, into a big bucket or tub of water and let them soak over night; capillary action will keep the rags and wood wet, and on the following day it will be found that the wood has absorbed a lot of water; next, put the bucket of rags and longerons on a brisk fire, let boil for an hour and the wood will be thoroughly steamed. Put the ends of the longerons to be curved in a curved jig to dry. The jig should be a curve drawn with a 55 in. radius. Let the longerons dry in this jig for 24 hours. When they are dry, place the longerons in their respective places in the assembly jig. Now install the vertical $\frac{5}{8}$ in. by $\frac{5}{8}$ in. spruce side struts using No. 6 $1\frac{1}{2}$ in. wood screws and casein glue. These struts should be made with greatest accuracy, using a miter box (a home made one is all right) to insure that the square ends are cut *square* and that the four center struts in each side panel are of exactly the same length, otherwise a crooked and unsightly pontoon will result. The screws in the longeron-strut end joints should be offset a little as shown in the detail drawing in the lower right hand corner of Fig. 3, to leave room for the screws holding the horizontal struts of the pontoon to the longerons. Watch this carefully. A word of caution in regard to the casein glue; mix the glue powder and water to make a smooth, paste-like glue, and mix a *fresh* supply daily. The front ends and rear ends of the longerons must be screwed and glued together in perfect bevel joints as shown in Fig. 3 in the corner detail, page 50.

When both side panels of the pontoons are completed, set them up side by side as they will be used in the completed framework, and install all the horizontal $\frac{5}{8}$ in. by $\frac{5}{8}$ in. top and bottom struts. To correct any temporary distortion during assembly, use a temporary diagonal bracing of $\frac{1}{4}$ in. by 1 in. slats nailed on with brads. Use a carpenter's square to be sure that everything is perfectly square, and a ruler to test for accuracy. Note especially the construction of the step which really incorporates four $\frac{5}{8}$ in. by $\frac{5}{8}$ in. horizontal bottom struts tightly screwed and glued together with No. 6 $1\frac{1}{2}$ in. wood screws, spaced 3 in. apart, see Fig. 4, to make a structure of great strength. The bow and stern pieces are considerably heavier than the regular horizontal struts and after installation are neatly shaped with a small hand plane. Now make a lot of corner gusset plates as shown in the detail (A-9) of Fig. 3, of 3/32 in. waterproof plywood, and screw and glue them to the top, bottom, and side struts as shown in Fig. 2 and Fig. 3, using No. 3 $\frac{3}{8}$ in. wood screws. Fig. 2 shows the top and side struts braced to each other with $\frac{3}{8}$ in. by $\frac{1}{2}$ in. stiffeners only, but before covering the pontoons plywood gusset plates were added. Two 3/32 in. plywood transverse bulkheads are applied at sections B-B and C-C as shown in Fig. 2 and Fig. 3, using glue and No. 3 $\frac{3}{8}$ in. wood screws at $1\frac{1}{4}$ in. intervals. These bulkheads are further stiffened with $\frac{3}{8}$ in. by $\frac{3}{8}$ in. spruce diagonals screwed and glued to them as shown in Fig. 2 and Fig. 3. Other internal diagonal stiffening struts of $\frac{3}{8}$ in. by $\frac{3}{8}$ in. spruce are applied as shown in Fig. 2, Fig. 3, and in one of the metal fitting details of Fig. 4. These stiffening struts must be fitted very carefully at their ends, which are fastened with small $\frac{3}{8}$ in. flathead nails and glue, for they strengthen the pontoon a great deal.

Metal Fittings

The metal fittings of the pontoon may be divided into two classes, internal and external. They are made as shown in Fig. 4. These fittings are rather easy to make, as it is only necessary to carefully draw the various patterns on soft cold-rolled sheet steel of the specified gauge and cut out the fitting parts, using heavy tin snips, a hacksaw, various files, cold chisels and drills. Accuracy is the main requirement. The bends are made carefully in a vise, the jaw of which has been padded with a piece of bent 20 ga. sheet copper, to prevent too sharp bending of the fitings. Never bend metal aircraft parts more than once in the same place. The "U" bolts are easy to make. Simply thread a piece of cold drawn steel rod on both ends with a 3/16 in. A.S.M.E. die, and bend it around a $\frac{3}{4}$ in. steel rod or pipe. All bolts which go through the skin of the pontoon must have their heads brazed to their internal metal fittings, so that they cannot turn when their nuts are tightened down from outside the pontoon. Note in the metal fitting details of Fig. 4 that a $\frac{5}{8}$ in. by $\frac{5}{8}$ in. spruce filler block is screwed and glued to the bottom of the top horizontal strut of each bulkhead, to give additional bearing surface for the center metal fittings. Note also that every horizontal bottom strut has its center connected to the center of the corresponding horizontal top strut by a $\frac{3}{8}$ in. by $\frac{3}{8}$ in. spruce stiffening strut.

At this point it is advisable to cover the bottom of the pontoon with $\frac{1}{8}$ in. plywood. From the bow piece to the rear edge of the step should be a continuous piece of plywood, and another piece reaches from the step over the stern piece. This plywood is attached with No. 3 $\frac{3}{8}$ in. soaped brass wood screws and a liberal application of casein glue. The screws are placed at intervals of $1\frac{1}{4}$ in. in both longerons and struts, see detail in the lower right hand corner of Fig. 3.

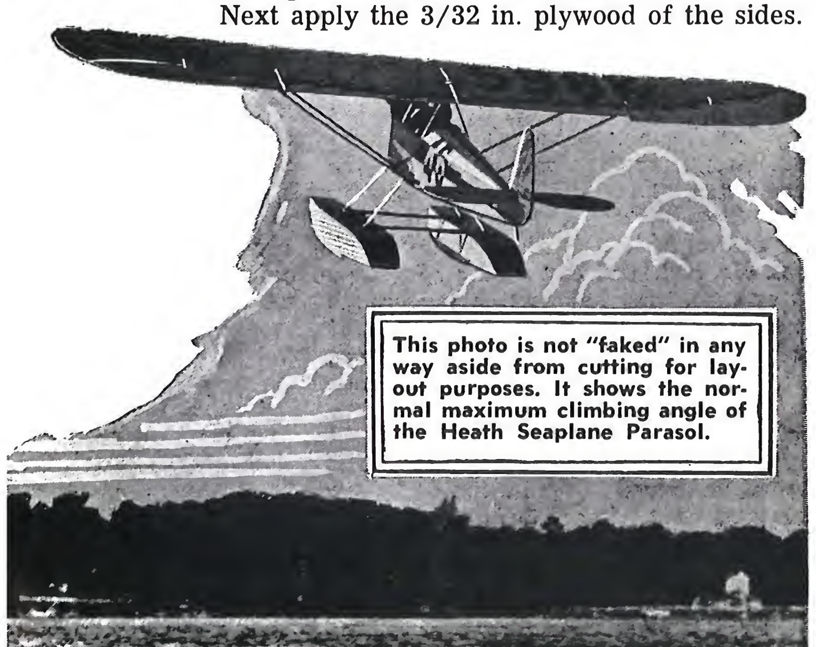
Now attach the long $\frac{3}{8}$ in. by $\frac{3}{4}$ in. bottom protecting stringers, using No. 6 $\frac{7}{8}$ in. screws, screwed up through the bottom plywood and into the horizontal struts of the bottom, using no glue and spacing them parallel 8 in. apart, see Fig. 3.

Attach a similar pair of stringers to the bottom, to the rear of the step. Note that the bottom plywood is reinforced on the inside by pairs of 7/16 in. by 7/16 in. by 10 in. spruce bottom reinforcing pieces, each pair occupying one of the spaces between horizontal bottom struts and parallel to them, see Fig. 3. Locate them as shown on the drawing and fasten each of them with two No. 3 3/8 in. wood screws, screwed through the plywood and into the reinforcing pieces at points 1 1/2 in. from the center line of the pontoon bottom. Now, with the aid of extremely accurate measurement, drill a hole with a 1/16 in. drill, down through the inside reinforcing piece, the plywood bottom, and through the center line of a bottom protecting stringer. Drill a similar hole down through the other stringer and repeat the operation until all of the bottom reinforcing pieces are so treated. Now, using these holes, screw No. 6 7/8 in. wood screws up through the stringers, and plywood bottom, into the inside bottom reinforcing pieces. This completes the attachment of the stringers to the bottom.

Making the Vent Tubes

Our next concern is the vent tubes which feed air to the step, see detail in Fig. 4. Each vent is made of a piece of 1 in. 26 ga. brass tubing about 11 3/4 in. long with an 18 ga. steel flange at each end. This tube has been flared slightly, as shown, at its lower end, by tapping the inside of its lower edge slightly with a ball peen hammer's peen, while the outside of the edge is rested against a vise or anvil. One of the large steel flange washers is then slipped down tightly against the flared portion of the tube, and the flare is soldered all around to the washer. The tube is then slipped up through a 1 in. hole in the bottom just behind the step, see top view, Fig. 3. This 1 in. hole is reinforced inside by a 1/8 in. plywood flange washer which receives the No. 2 1/4 in. wood screws, which hold the soldered flange of the vent tube after they are screwed up through the bottom. This joint between the flange and the bottom should be smeared with Jeffrey's Marine Glue to make it watertight, but the glue is applied only in the final assembly, when the pontoon is covered with linen.

Next apply the 3/32 in. plywood of the sides.



This photo is not "faked" in any way aside from cutting for layout purposes. It shows the normal maximum climbing angle of the Heath Seaplane Parasol.

This is applied as two pieces per side, with the edges butted together to form a splice at D-D on the left side and C-C on the right side, in order that the splices will not all occur at one section. To give more gluing surface 3/8 in. by 3/8 in. spruce strips are nailed and glued to the front and rear sides of these vertical struts, which bear the splices. Allow the end of the bolt of each "U" bolt fitting to protrude through the plywood, and see that the large washer brazed to its head, inside the pontoon, is securely attached to the vertical strut with No. 3 3/8 in. wood screws, see Fig. 4. At this stage the entire interior of the pontoon must be given a thorough coat of a mixture of equal parts of linseed oil and Japan dryer.

Making the Plywood Top

The plywood top is made of two pieces of 3/32 in. plywood with the ends butting together to form a splice at the first horizontal top strut to the rear of the front bulkhead. 3/8 in. by 3/8 in. spruce strips are nailed and glued to the front and rear sides of this splice-bearing strut to give more gluing surface. The hand holes and vent tube holes should be cut before the top plywood is attached to the pontoon, and these holes should be reinforced inside by large washers of 1/8 in. plywood held by No. 2 1/4 in. screws and glue as shown in Fig. 4. The upper vent tube hole is slightly beveled to hold some greasy string packing, and when the upper flange washer is slipped over the upper end of the vent tube and screwed down against the pontoon top, a watertight sealed joint results. The ends of the bolts of the fittings, attached to the tops of the bulkheads at the center line of the pontoon top, protrude through holes in the top plywood.

The hand hole covers are made in this manner. Two circular pieces of 1/8 in. plywood are glued and screwed to each other as shown in Fig. 4 with No. 2 1/4 in. wood screws. As the upper piece is 6 in., and the lower piece 5 in. in diameter, the lower piece plugs the hand hole neatly, and the upper makes a flange bearing against the top of the pontoon, and a greased 1/32 in. thick soft gasket between this flange and the pontoon top completes the watertight seal. To draw this cover down tightly against the gasket a 10-32 bolt through the cover's center is used, with its nut soldered to the center of a yoke spanning the inside of the hand hole, see Fig. 4. The ends of this yoke, which is made of a strip of 20 ga. sheet steel bent to a channel section bears against two 3/8 in. by 1/2 in. pieces of spruce nailed and glued on edge to the under side of pontoon top in such position that each piece cuts off an arc equal to about one-fourth the circumference of the circle represented by the hand hole. These strips of wood have the effect of giving a four point application of the pressure of the yoke to the hand hole rim when the bolt is tightened, see Fig. 3 and Fig. 4. Two protruding screws in the 3/8 in. by 1/2 in. pieces prevent the yoke spinning around when the bolt is tightened. Before attaching the top plywood give its under side one thorough coat of a mixture of one part linseed oil, and

fittings that go on the fuselage and then weld them on in their respective places, motor mount lugs, landing chassis lugs, and so forth.

Special care must be used here for all things must have the exact measurement. Otherwise the parts that fit these lugs will not go on if "out" any. After the fuselage is all welded and the lugs welded on, then give it a painting of lionoil, which protects it from rust.

Empennage

The next thing is to build the empennage, which is a rather simple procedure. First thing to do is to get the outline laid out on the same table that we used to lay out our fuselage, and cut the tubing to fit and spot this the same as you did the fuselage. Take out the spotted framework and weld up. When you have all of the empennage welded, put the control horns on to the elevators and rudder in their respective places, making sure that they are exactly in line.

You will find that the empennage will warp considerably in the part that the light tubing is used, but with a little careful checking and lining up by hand, bending cold (for there is only slight bending to be done) you will get a perfect job. But let me tell you here that there is a little trick to heating a steel tube in the proper place to get the right results. That is, heat the tube on the side that the bend is to a dull red. At first this actually increases the bend but when the tubing cools off you will find that it has assumed an angle opposite to the original bend and almost invariably comes out exactly straight.

In handling small gauge tubing extreme care must be used not to get this metal too hot and burn the tubing because it is a very easy thing to do and, of course, might cause disastrous results after the ship is flying.

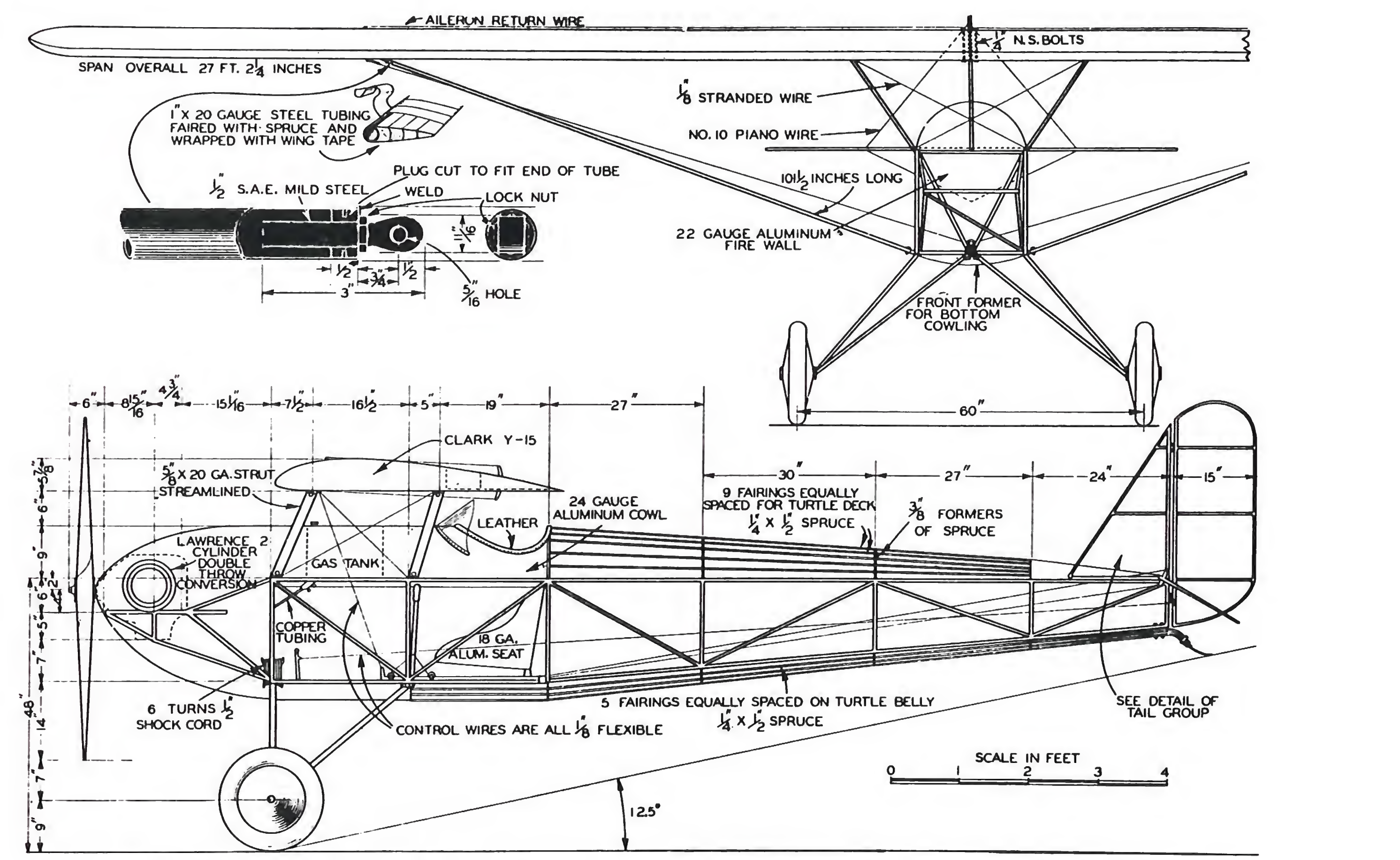
The best way to tell if the weld is good is as follows: the weld must be good, clean metal, looking as though new metal had been placed there. A poor weld has a sand effect on the outside, or is very scaly. If any of these faults show up it is always best to throw that piece away and build a new piece. It will cost more, it is true, but nevertheless it is always best.

Fittings

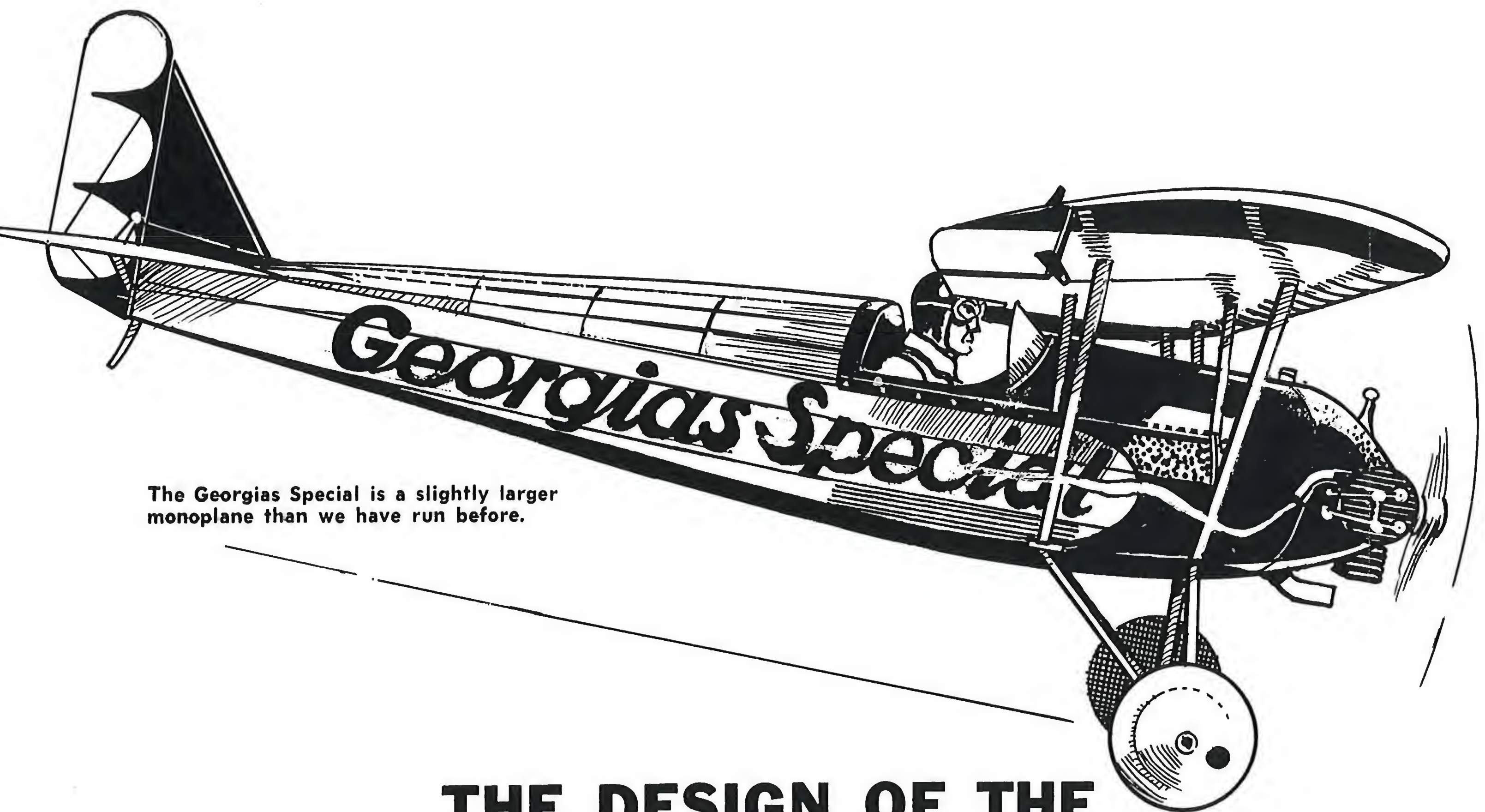
This work is also another very important part of the work. All fittings are designed to be cut out of sheet steel and not more than one bend must be made in these fittings before they are used on the ship. The wing fittings should be installed upon the spars before the ribs are slipped on. Extreme care should be taken in cutting and boring the holes, for these fittings are a very vital part of the airplane.

Landing Gear Lugs

These lugs are made of three-eighths by six-



From these drawings one makes the full size drawing for the layout so the fuselage can be welded.



The Georgias Special is a slightly larger monoplane than we have run before.

THE DESIGN OF THE GEORGIAS SPECIAL

By Orville Hickman

Well, here we are, boys — with something a little advanced. I expect that you have been waiting for some time for this kind of a plane to build; all steel but the wings, and they are of the conventional wood type.

The first thing we will start on is the fuselage. It is rather simple when we know how to go about it. First get your tubing that you are going to use for the longerons and then lay a plan of the side of the ship out on some level surface, preferably a wooden table so that you can drive nails around your outline to lay the tubing into. This work of laying out the fuselage side on the table must be very carefully done or our good intentions are defeated before we get very far. After we get the side laid out we put the pieces of tubing into the outline that we have made and cut the vertical and diagonal pieces to fit. All joints must fit closely and neatly, otherwise we will have to use an undue amount of welding rod to get the holes filled up. This does not make as strong a joint.

When all of the pieces are laid, get a welding outfit and if you are not a good welder get someone who is and just "spot" the joints all together with the welding rod — not too much — then make the other side. It is the same so you can use the same jig. After you have completed the second side take out the side and draw another diagram of the top of the ship on the table and drive your nails in. Place the two sides on that outline, with the top longeron down and the vertical sides perpendicular to the table. Be sure that these sides are straight up and down. The best way to assure that is to use a carpenter's square. After plumbness is determined cut your pieces to fit horizontally and tack them to the sides with a torch. Also put in the cross bracing on the top and bottom and the internal diagonals and all other bracing that the plans call for.

Now the fuselage is ready to take out and weld. The best plan to do this is to weld one bay at a time going around the fuselage laterally a joint at a time. You will find this method the best, having the least amount of warping.

After this operation is complete cut all of your

one part Japan dryer, being careful to leave the surface around the edges unpainted, as they will be screwed and glued to the top longerons. When the oil coating is dry, apply the top plywood. The entire pontoon is now covered with plywood and it will be necessary to round all the edges neatly with a sharp plane as shown in the detail in the lower right hand corner of Fig. 3, and the step detail of Fig. 4. At this state withdraw the vent tubes, remove the bottom stringers, and give the entire outside of the pontoon a coat of a mixture of one part linseed oil and one part of Japan dryer, then allow it to dry at least 24 hours.

The pontoon must be covered with genuine Irish linen when dry. Do not try to use cotton, for linen sticks to wood so much better and is not so easily damaged by abrasion in use. Cut a piece of this fabric large enough to cover the entire bottom. Put a liberal coating of wing dope on the bottom, and before it has time to dry at all, stick the fabric to it, saturating it freely with a large dope brush and smoothing it out perfectly with the fingers and the wet brush. As soon as it is dry, trim off the edges neatly. Now cover the sides and top in the same way, allowing the bolt ends to protrude through holes in the fabric. Cut away all excess cloth and tape all the seams neatly with dope-saturated 2 in. pinked-edge aircraft tape brushed out smooth with a wet dope brush. Give the pontoon six coats of clear wing dope and two of pigmented dope, preferably silver. When dry give it two coats of fine spar varnish, allowing each coat at least 24 hours for drying. When the varnish is dry, with a sharp pen knife cut out the cloth which covers the hand holes and vent tube holes. Then install the vent tubes permanently and attach the hand hole covers which have been enameled black with auto enamel. Now is the time to attach the external metal fittings, using the bolt ends which protrude from the pontoon. Re-attach the bottom protecting stringers, using the old screw holes in the bottom, and be sure and grease these screws thoroughly.

When both pontoons are complete, the pontoon gear struts must be made. The two horizontal spreader struts are of such length as to space the center lines of the pontoons parallel and 4 ft. apart. These struts are made of $\frac{3}{4}$ in. 20 ga. 1025 mild steel tubing, or Shelby seamless steel tubing. Their ends are reinforced for the last 3 in. by 3 in. lengths of $\frac{5}{8}$ in. 20 ga. tubing telescoped inside them. The ends of these spreader tubes are heated cherry red, then squeezed flat in a vise, and drilled for the $\frac{1}{4}$ in. S.A.E. cap screws which hold them to the external center line metal fittings on top of the pontoons, see Fig. 4. The spreader tubes are also held by the "U" bolt fittings at the inner edges of the pontoon tops. The four struts attaching the pontoons to the bottom longeron wire pulls of the fuselage are a little harder to make. They are made of $\frac{5}{8}$ in 18 ga. steel tubing. They have 3 in. steel tube reinforcements of the next smaller size tubing of the same gauge, slipped into their ends, which are then heated red, flattened, and bent, as shown in Fig. 4, at their lower ends, and slotted and flattened at their upper ends. Both ends of each strut are drilled for $\frac{1}{4}$ in. bolts. If the plane the pontoons are to carry is the bolted-fuselage type "Super Parasol", the front struts should be 23 in. long between the bolt hole centers, and the rear struts $22\frac{3}{4}$ in. long between bolt hole centers. If the plane is a welded-type fuselage "Super Parasol", both front and rear struts should be $23\frac{1}{4}$ in. long between bolt hole centers; $\frac{1}{8}$ in. aircraft cable strand is used to brace the pontoon gear. Only six cables are used. The two front struts are secured by $\frac{1}{4}$ in. eyebolts through their upper ends, which are forked over the original wire pulls welded or riveted to the bottom longerons. Each eyebolt carries two cables. One, with a short No. 326 female turnbuckle, runs to a 3/16 in. clevis attached to a shackle held by the $\frac{1}{4}$ in. bolt holding the end of the front spreader tube attached to the opposite pontoon, while the other cable with a long No. 326 female turnbuckle runs diagonally downward to a 3/16 in. clevis attached to a 3/16 in. shackle on the $\frac{1}{4}$ in. bolt holding the end of the rear spreader tube to the opposite pontoon. Another pair of cables with long No. 326 female turnbuckles connect the front fittings at the ends of the spreader tubes with the rear landing gear wire pulls of the bottom longerons, one cable occupying each side bay of the pontoon gear strut system, see Fig. 1, Fig. 3, Fig. 4.

The Handling Truck

When the pontoons are properly positioned, the center line of the front spreader tube will be 3 in. ahead of the center of the front landing gear wire pulls of the bottom longerons if the fuselage is of the bolted type, and $4\frac{1}{2}$ in. ahead if the fuselage is of the welded type. When the pontoon gear is rigged or adjusted properly, spruce streamline section fairing should be attached to the backs of the struts and spreader tubes, using a spiral bandage of 2 in. pinked-edge tape and six coats of wing dope, four clear and two pigmented coats.

The handling truck, a necessary item of seaplane equipment is so simple that it can easily be made by following the drawings in Fig. 5. It consists of a strong rectangular frame on two wheels. 3 in. by 14 in. aircraft wheels were used on the original trucks but as they are rather expensive, Heath is also supplying 2 in. by 16 in. steel implement wheels which are cheaper and serve just as well.

If the pilot is to be a very heavy man, it may be necessary to move the pontoons back a little further than the recommended adjustment. With engine dead, the seaplane should be able to face a 20 mile head wind without dropping the tail into the water. If the tail should touch the water under these conditions, move the pontoons back a little.

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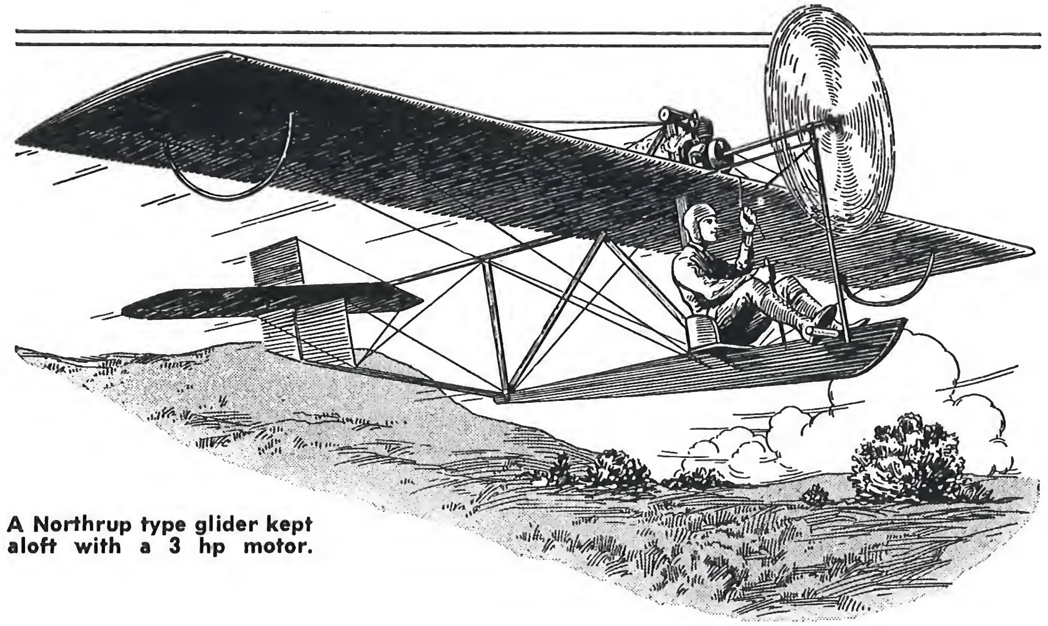


A Northrup type glider kept aloft with a 3 hp motor.

The O. H. Conversion Glider Motor

With this glider converted from a Smith Motor Wheel, sufficient power can be developed to keep a glider in the air once it has been launched. The conversion of the motor is not difficult, as explained here by Mr. Hickman, well known to Modern Mechanics *readers.*

By Orville H. Hickman

Back in 1923 at the English lightplane meet held at Lympne, there was a lightplane, little more than a powered glider, which flew with a motor of 3.6 hp. The name of this plane was the Wren.

It was a glider of high aspect ratio with the motor mounted between the wing spars. From its flywheel a shaft was run out on an outrigger to the little prop, which whirred at a high rate of speed not far in front of the pilot. The engine was a converted small size single lung English Douglas motorcycle motor.

Probably, in a subconscious way, this glider gave me the idea of taking a Smith Motor Wheel engine, and converting it for use on gliders like the Northrup, published recently in this magazine and now available in the 1930 *Flying Manual.*

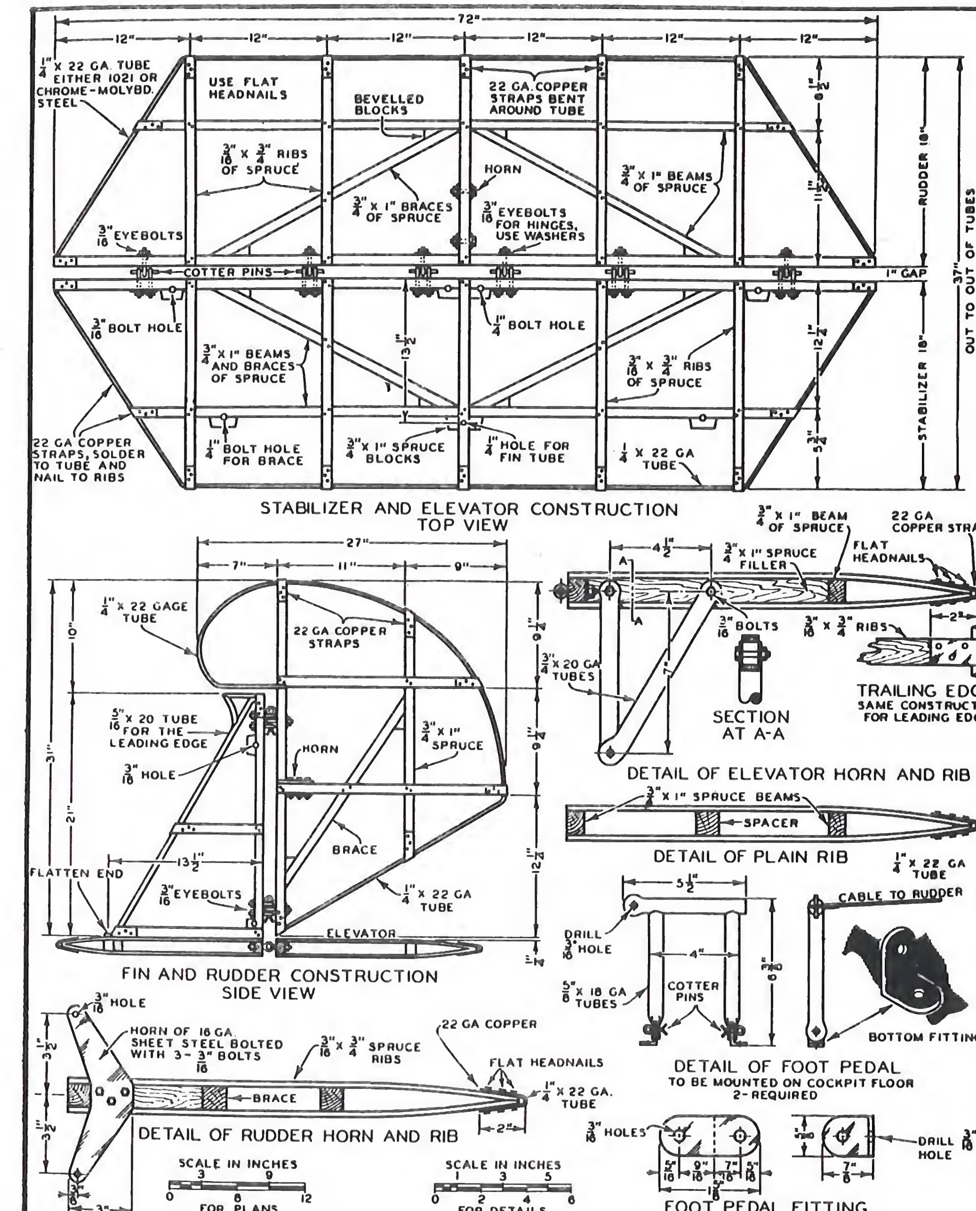
So in presenting the conversion here I am sponsoring nothing new. It will serve to keep gliders aloft in country not naturally favorable for gliding. I doubt if it will take off a glider, but in the rugged primary type of glider, I'd be willing to gamble that it'd kill sinking speed to the zero point, if not give a small rate of climb. It develops 3 hp at 2,600 rpm on a weight of 38 lbs. It is a rugged engine, will always run and will furnish its own ignition from the flywheel mag. Other weight, such as bed, tank and fuel load, is dependent upon your own installation.

First let us look at the crankshaft, for it is here that most of our conversion takes place. The first operation is to remove the flywheel and the back plate which covers the timing gears. In this connection it is appropriate to explain that this motor is a four-stroke cycle type, and if the gearing is not already marked it is best to take care of this so that the timing will not be a problem in assembling.

Now that the cases are off, together with the flywheel, the next step is to remove the bottom of the crankcase and take the connecting rod loose. At this point it is advisable to make sure that the rod has the proper fit. It is essential that it fit correctly, for when used in the glider the motor will run at full throttle, and a connecting rod that is too loose or too tight is likely to cause trouble with the motor. After making sure that the rod is properly fit, and taking steps to correct it if it is found unsatisfactory, remove the rod and take out the crankshaft.

Now, taking the face that is next to the thread-

Here are the balance of the very unusual details of this most unusual little airplane. It should prove easy to build, and if carefully made will fly very well. Note the rudder control.



COMPLETE PLANS FOR ASSEMBLY OF TAIL

er" hinged to the horizontal fuselage strut. From the other side of this rider the rod goes straight to the elevator horn. A plywood guide is placed halfway back to prevent vibration. The pushrod is 3/4 by 22 ga. clear through, and the little rider is simply an inverted "V" of 1/2 22 ga. tubing. The stick itself is 3/4 by 20 ga. and has a universal joint at the bottom, which you will have to make up out of sheet in the shape of two clevises. The aileron cable turnbuckles connect to a flat piece of steel about 3 in. long, which is put through a slot in the stick and brazed in. Holes in the ends of this piece take the turnbuckle pins. A sort of universal joint must be made for the pushrod and another at the rider. Do your best and be sure it is strong.

Covering the fuselage is simple. Pieces of half-round 3/4 in. spruce molding are laid along the center of the sides, top and bottom and fastened with soft wire. The fabric is pulled tight and tacked to these and the seams taped over.

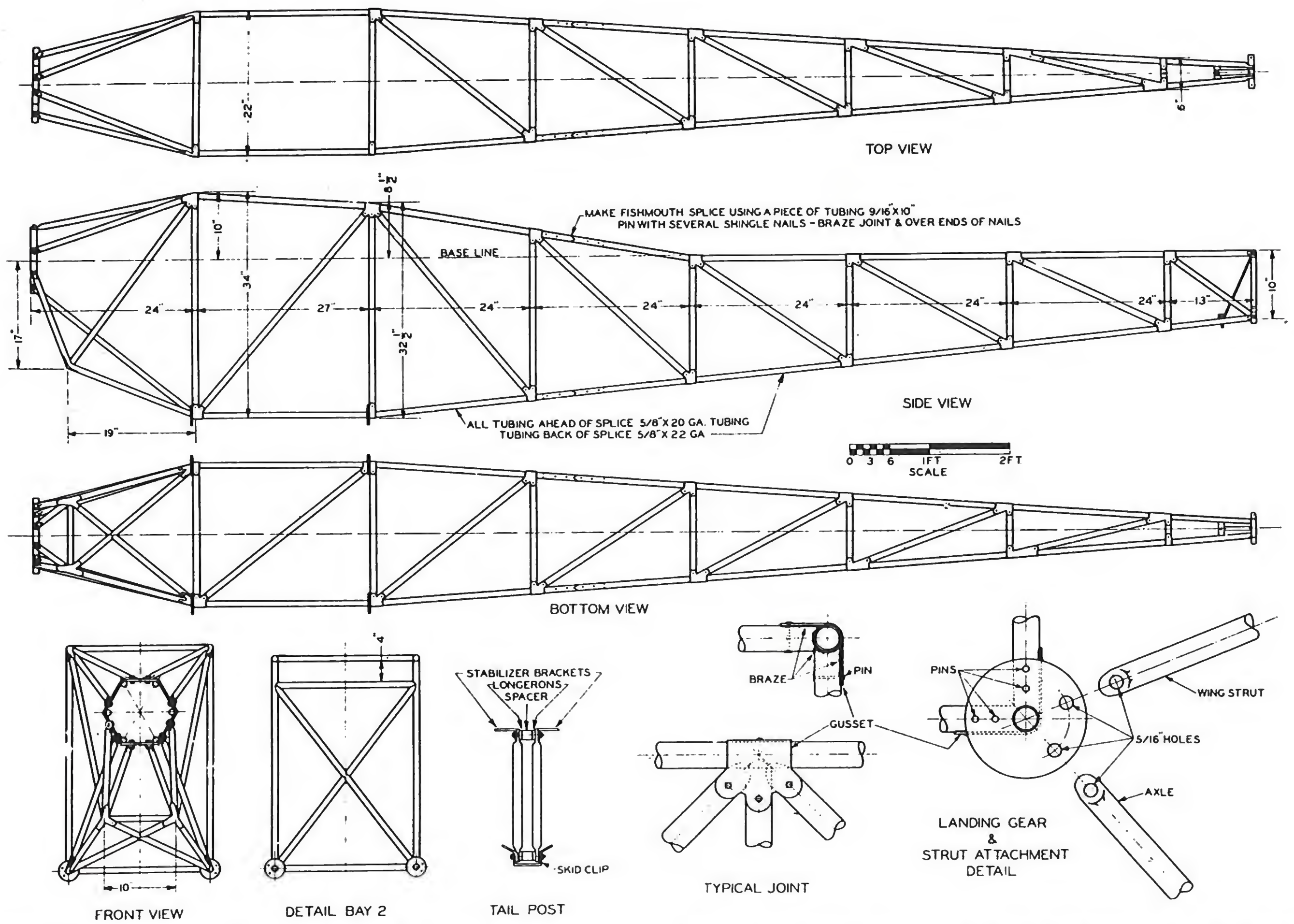
Attach the tail group next. Two 16 ga. angles at the rear of the fin are held to it by one 1/4 bolt, and 1/4 bolts are run through these angles down through the stabilizer and the angles on the fuselage. A single bolt goes through the front of the fin and through the stabilizer and through a reinforced hole in the short horizontal fuselage strut.

The front stabilizer braces are 1/2 by 22 gauge tubing, bolted at the bottom to reinforce gussets at the bottom of stabilizer station, and at the tops to the beams. The rear bracing is the same type struts as in front on the lower side, but the upper bracing is No. 14 hard wire and turnbuckles attached to pulls near the top of the fin. True up and attach the elevator and rudder.

And now you can bolt on the wings, cut the struts to give about 2 deg. of dihedral and rig the control system. True the wings square and keep them there with the diagonal braces between the struts. These cables are 1/8 and the pulls at the ends 16 ga. Be sure to safety all turnbuckles. The tires may be either 18 by 3 or 20 by 4 as the same wheel takes either size.

Balancing is the final job. Place a short length of 2 by 4 timber from beam to beam just outside the wing struts under each wing and lift the ship up onto high horses that have a rounding top. With the wheels clear of the ground and pilot in the seat the ship should balance evenly with the weight supported 30 percent back from the leading edge of the wing. If nose heavy use a heavier skid or place a small bag of shot at the tail. If tail heavy move the seat forward a trifle.

And finally, DON'T try to fly this ship unless you are a regular pilot. Get a test pilot to try it out, and take at least enough lessons at a flying school to solo. When you have done that the air is yours. •••



The joint at the fourth vertical bay at first glance looks as though there might be a redundant member there, but hundreds of hours of flying time have proven the job entirely strong enough. The fuselage is made by placing the enlarged drawing of this print on a bench, and using the diagram as a jig. You will also note that the motor mount is secured solidly. The joints are simply pin joints, easy to make.

20 ga. brace that runs forward to the reinforced pedal station gusset where it is bolted. The eyebolt also takes the 1 by 20 ga. brace that runs from the strut up to the dash.

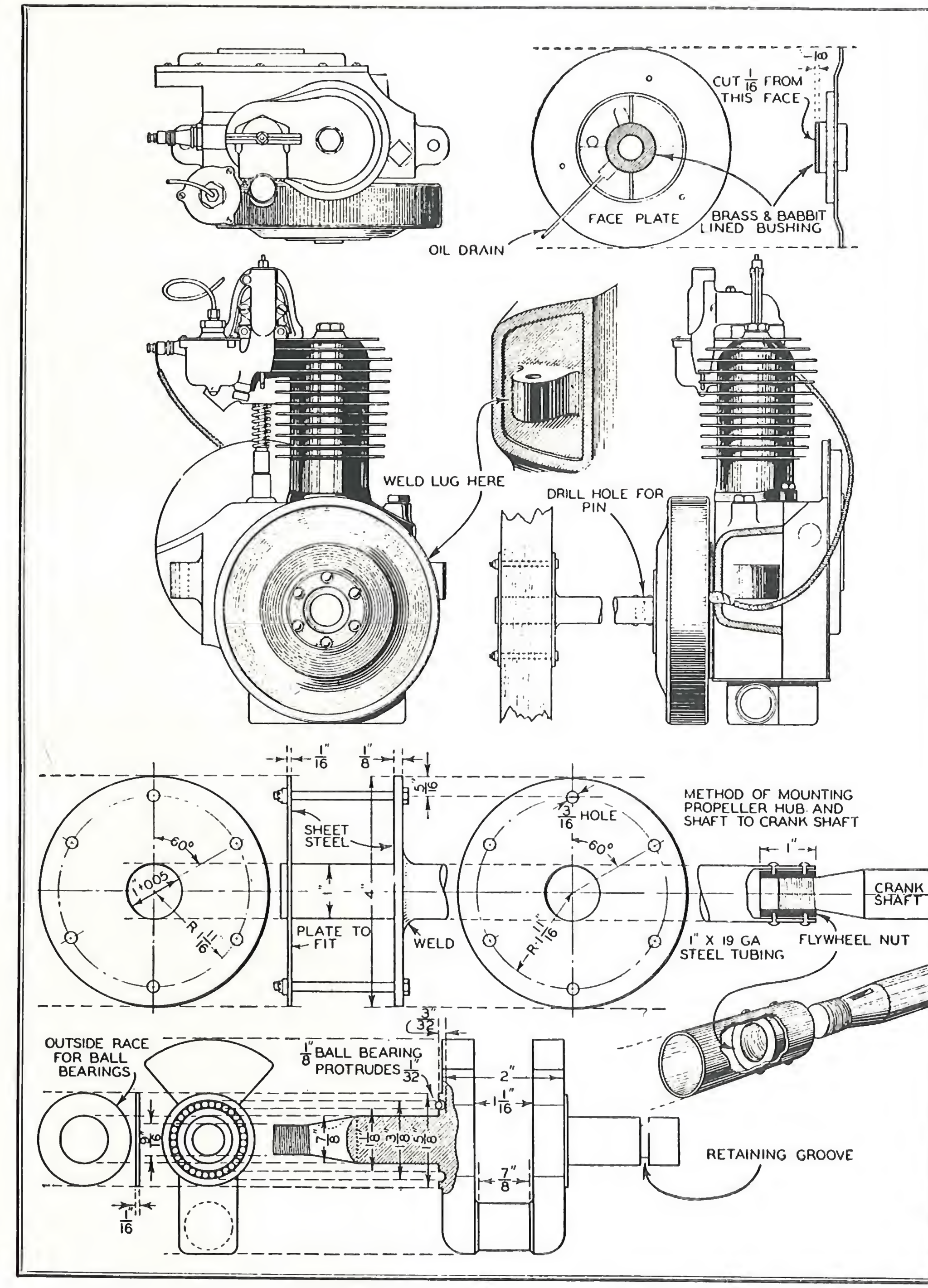
The dash is a piece of ¾ by 7½ spruce carefully fitted between the struts and held with an 18 ga. clip at each end. On it are mounted the throttle and instruments, but do not cut too many large holes in it, for it is a stress-member. At the rear of the cockpit is a similar piece only 4 in. wide to which the rear spars bolt.

The floor of the ship is ¼ plywood fastened to the longerons and struts with clips. The seat may be your choice, except that it must be about 8 in. off the floor in the center to allow the elevator push rod to pass back under. The tank is of sheet galvanized iron and holds 4 gals. A 1 gal. compartment is built in for oil. It is fitted with connections for pipe line and mounted to the dash and longerons between the dash and motor. The top of the station back of the cockpit is covered with 3/16 plywood as a means of getting in and out. A step is cut in the fabric as shown. The front of the tail skid is bolted to a flat plate across the lower longerons, and this plate is braced by 3/16 rods as shown.

Now comes the control system, one of the hardest jobs on the ship. The rudder works by pedals and the rigging is simple, but the stick is complicated and would take too much space to describe fully. You will have to work out your own salvation. If you can get a look at a Jenny you have the whole thing. Briefly, the rudder cables are 3/32 flexible aircraft cable and run almost directly from pedals to horns. The cables run through 2 in. lengths of bakelite or copper tube securely wired to the fuselage at intervals. The aileron cables are ⅛, and run from eyes on the stick down through and under pulleys fastened to the lower longerons, up along the wing struts, into the wing through a short length of copper tubing stapled to the beam, through the inside pulley and to the horn.

The top horn cable goes through the other pulley and along in front of the beam, is connected to a turnbuckle between the longerons and just in front of the dash and thence through to the top horn on the other wing. A cable from the lower horn of this other wing back down to the stick completes the circuit. Use care and see that everything works smoothly and that the cables have no chance to jam or bind.

The pushrod passes from the stick under the seat and to a "rid-



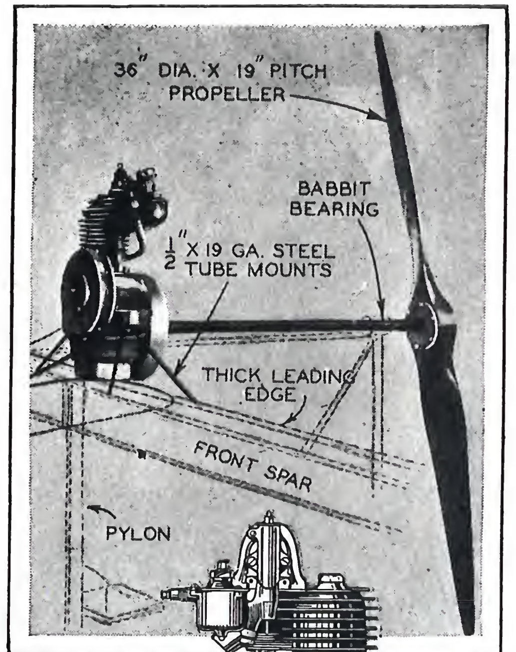
This drawing gives the essential details of the motor conversion, showing how the propeller extension shaft is attached to the crankshaft, how the groove is cut for the ball bearings, and other details.

ed end and the one that works against the brass bushing, lay out carefully the desired placement of the groove that is to be your thrust bearing. This groove can be cut by making a tool for the lathe of the same contour and size as a ⅛ in. ball bearing.

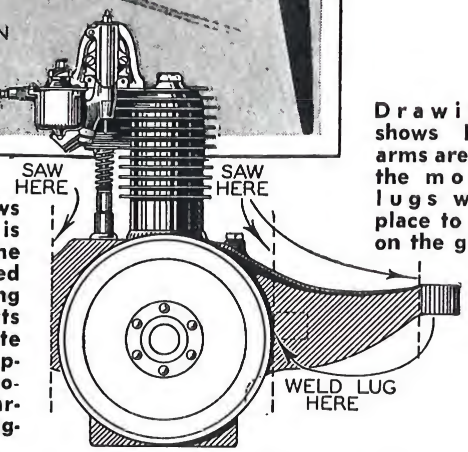
Cut this groove with the utmost care. Be sure you do not get the groove more than 3/32 in. deep, for it is necessary to have 1/32 in. of the ball bearing project from the groove to furnish a surface for the steel washer to bear on. Thirty ⅛ in. ball bearings will be required to fill the groove. After you have finished cutting the groove, place the bearings in it. Now make the steel washer as shown in one of the accompanying drawings. There is nothing complicated about the washer; it simply fits over the shaft and presses against the ball bearings. It is a good idea to make the washer a rather tight fit so that when it is slipped on it will hold the ball bearings securely in place until you get the shaft reassembled in the case again.

You will find that there is a little groove right next to the thrust bearing face that will let the steel washer revolve freely on the crankshaft, so it is quite a little trick to get the steel washer to stay on the shaft close enough to keep the balls in the groove.

Now you are ready for the next step. You will find that there is a face plate which holds the coils



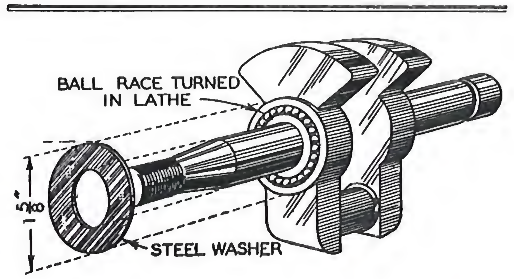
The photo shows how the motor is placed in the glider, the dotted lines indicating how the supports are placed. Note the tripod support for the propeller shaft bearing, insuring rigidity.



Drawing left shows how the arms are cut from the motor and lugs welded in place to mount it on the glider.

of the magneto and the breaker points. This has a brass bushing which requires to have 1/32 in. removed from it in a lathe, since it is very important that it have a perfectly flat face so that all of the ball bearings will come into use evenly. Otherwise you will encounter considerable trouble in uneven wearing.

When you have completed this operation it is time for assembly of the case plate. These motors were not originally intended for aircraft work, and as commercially produced, a too generous amount of clearance is left in the crankshaft end bearings. This will have to be taken care of on the side opposite the thrust bearing so that there is very little play. If this is not done there is danger of the ball bearings dropping out of their groove, ⅛ in. play

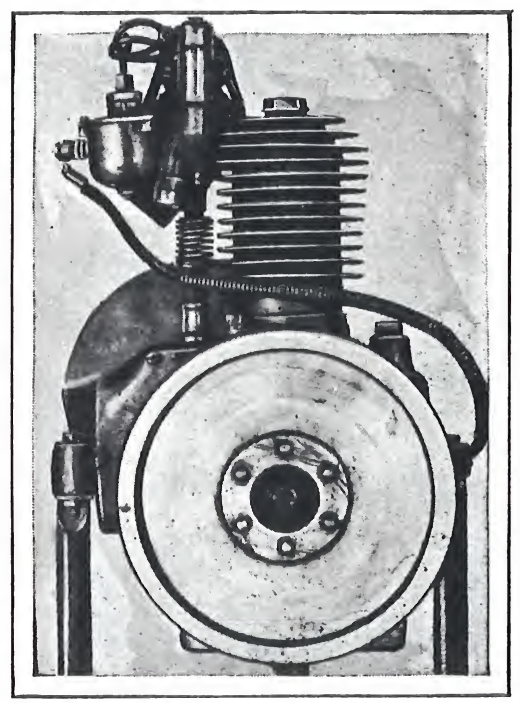


Showing the ball bearings in their specially cut groove, with the steel washer ready to be slipped in place over them.

being quite sufficient to bring about this undesired result.

The propeller extension shaft and hub comes in for attention next. The extension shaft is made of 1 in. by 19 ga. tubing which fits over the end of the crankshaft. The drawing gives a good idea of how the connections are made. The plug that is required must be cut to such a diameter that it will just slip into the tubing. This can be put on in different ways. In addition to the method shown in the drawing, another way is to braze the plug onto the tubing. Also the flywheel nut can be ground round and welded in. The rivets that are used are ⅛ in. steel and are put in as a press fit. Eight are used, equally distributed over the plug and the tubing.

Length of the propeller extension shaft will, of course, be determined by the placing of the motor, which in turn depends upon the design of your glider. In case the shaft is to be more than



Front view of the motor ready for mounting.

3 ft. in length it is best to use more than one bearing. The end bearing is securely attached so that it cannot move out of place. In converting this motor it is, of course, understood that it is to be used as a tractor type.

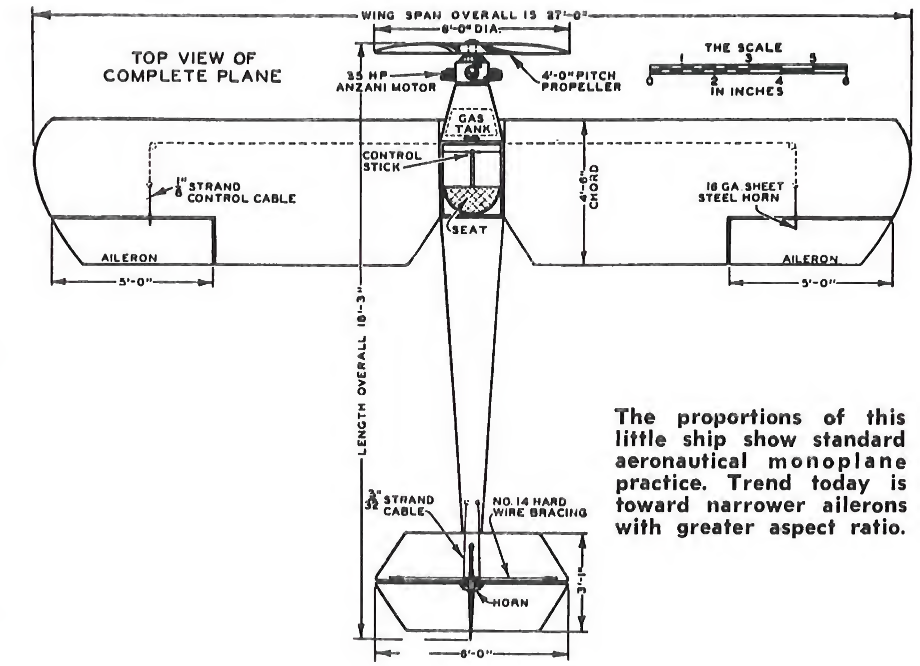
The plates for the hub of the propeller are almost self-explanatory in the drawing. It is worth taking special pains to make sure that the plates are perpendicular to the shaft and that the holes for the propeller are lined up accurately. The best method is to bore the holes in the plates at the same time, one being beneath the other.

You will find that there are two arms on the crankcase of the motor as designed for its original purpose of propelling bicycles and small vehicles. These arms were used to hold the wheel fender and gas tank which were used to hold the machine

from there back is ⅝ by 22 ga. Make a fish-mouth splice with a 10 in. piece of 9/16 tubing inside and with several shingle nails put through. Braze the fish-mouth and over the ends of the cut off nails. The four struts at the front and rear cockpit stations are ¾ by 20 ga. All the rest is ⅝ by 20 ga. For the wing strut and axle attachments a simple 3 in. disk of 11 ga. steel is cut and a ⅝ hole drilled in the center. The 5/16 holes are drilled as shown and the disks slipped over the longerons before assembly. This gives a concentric hitch that is very strong and easily made.

Build up the two sides as far as the front cockpit station complete. Cut struts and braces with hacksaw and grinder till they are a good fit and then braze them in carefully. Slip a piece of sheet iron under the job to keep from burning the jig. When done take them out and stand up on the floor side by side and fit in the front and rear cockpit cross struts. While still hot, bend the longerons so that the two sides are 6 in. apart at the front stabilizer station. Fill in the struts and braces as before, keeping careful watch that the longerons are straight. Use a square on the job frequently to keep everything trued up. Next put in the vertical diagonals, not shown, with a final check for squareness. The tail post is double as shown and is put together with 5/16 bolts that have had the heads cut off and the shank threaded. Spacers are used to allow the ¾ push rod to work between the two struts. If desired the struts, longerons, which are flattened, and the stabilizer and stabilizer brace brackets may be brazed together. The clip for holding the tail skid is 16 ga. by 1 in. wide. The skid itself is spring steel 3/16 thick.

All the gussets up to the cockpit station are 20 ga. sheet steel. They are cut to fit the place and carefully brazed on after which the holes for the rivets are drilled and the rivets, which are 3-penny nails, are put in with a drive fit and brazed over. The axle and strut disks are carefully brazed to



The proportions of this little ship show standard aeronautical monoplane practice. Trend today is toward narrower ailerons with greater aspect ratio.

both vertical and horizontal struts and then pinned as before. To take the pull of the wing struts a 16 ga. by 1 in. sheet steel strap is doubled over the longerons at front and rear cockpit stations and a piece of 3/16 cable and heavy turnbuckle put in to safety the fuselage in case the horizontal strut were to fail under heavy strain.

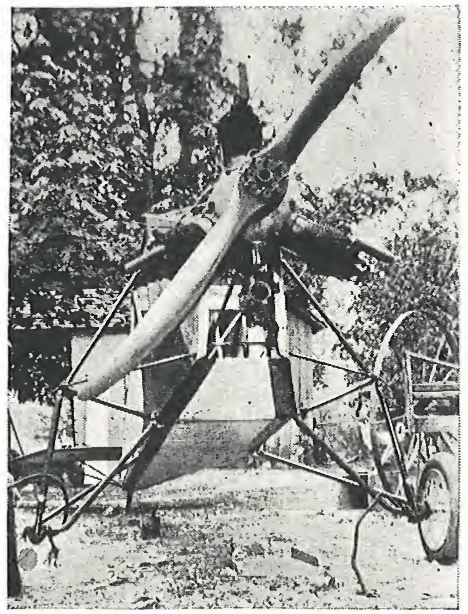
The motor mount is simple and strong. Pieces of 14 ga. tubing are cut that will be a working fit on the mounting bolts on the engine. These pieces are ¾ of an inch long. They are placed on the bolts and then a length of bar steel, 3/16 thick by ¾ wide is carefully bent around them, making a hexagon or octagon shape as the case may be. The ends of the strip are lap jointed and riveted and brazed. The completely formed ring is now placed back over the short lengths of tubing and the pieces are lightly brazed to it. After taking the completed ring of the bolts all the pieces of tubing are carefully brazed again. As heavy washers are used in bolting on the motor they bear both on the ends of the tubes and the ring itself, making an unbreakable job.

Use care in mounting the ring to see that it is square with the fuselage in all directions. Flatten the longerons at the proper place, reinforce them and fasten to the ring with 3/16 steel rivets, after which braze over the whole job. Such a joint can not be wrecked.

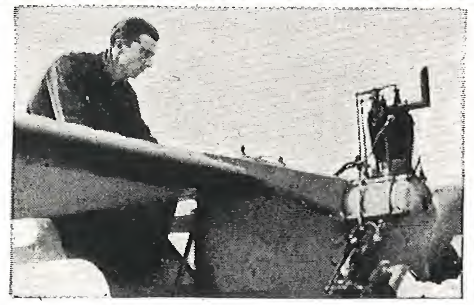
A word about reinforcing. The end of the tube is heated red, it is flattened and elliptical pieces of sheet steel are laid on both sides and bent to the shape of the tube and then brazed all around. This distributes the strains back up on the tube and makes a safe job.

The landing gear is the simplest that can be built. The axle is 12 or 14 ga. tubing. The rear radius member is 1 in. by 20 ga. tubing. A disc exactly like those for the fuselage is brazed on as an end bearing for the wheel hub, and to this disc the radius rod is riveted and brazed. The shock strut is 1 by 20 ga. with a 6 in. slot that just fits the axle built up at the lower end as shown. The shock cord is wrapped around the lower crosspiece of this slot and up over the axle, making a simple fool-proof job.

It will be noted that the front wing struts are cut out about 14 in. from the fuselage. The ends are reinforced and the outer length is shaped to telescope over the short piece about 3 in. Through this joint is put a 5/16 eyebolt, the eye of which makes the bearing for the shock strut. This eyebolt also takes the 1 by



Above—Les Long climbs into the cockpit of his new Longster as a few spectators gape. Wide tarmac, foggy in the early morning; a new ship, and the thrill of the first test hop! What private pilot could forget the thrill of such an event? Note Les' peculiar rudder design and braced wing.



Left—A good idea of how the skeleton of the plane looks with the Anzani 35 hp motor.

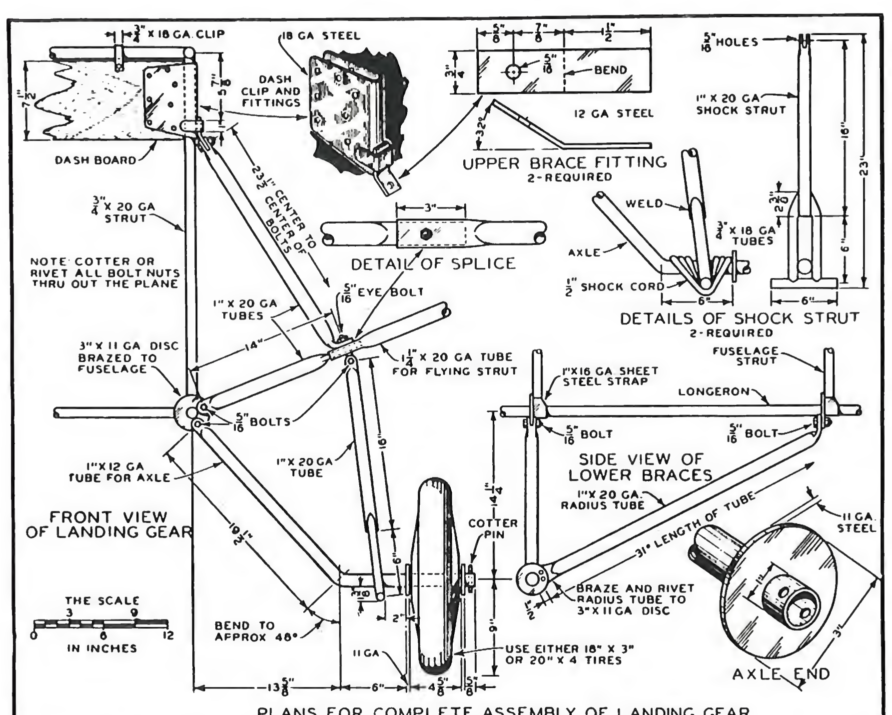
the rib jig the same as a rib, but stopping at the rear of the front spar. The end rib of the wing is about half as high as the others, made of ¼ plywood with lightning holes. This is to give a neat slope to the fabric.

The ailerons are made up right with the wing. In making the ribs four of them for each wing are made with the vertical strut that comes just back of the rear beam set back 1¼ in. This allows for a space of 1 in. between rear spar and aileron after the ¼ in. thick front aileron spar is fastened in. The rear aileron spar is slipped in likewise to the rear of the final vertical rib strut and glued and nailed. The rib that supports the control horn is filled in with ¼ plywood to which the horn is bolted. The horn is 16 ga. sheet cut as shown. Hinges are standard eyebolt. Cover and dope the wings the same as the tail group, and that's that.

The fuselage construction is rather unusual, but it is the only practical method for the amateur builder who wants a self-braced job. Welding is out of the question unless you can afford an experienced man's services. For that matter, welding on 22 ga. tubing is always a dubious proposition. We made many tests and the joint adopted is stronger in every way than the welded one. To bring steel to the brazing point does not hurt it and it will have its original temper when cool, while welding leaves the metal soft and weak. Bronze is ideal in many ways, for it flows into cracks easily and has great strength in a shear joint. Used with the gusset-plate method it gives an indestructible joint, besides leaving the tubing in its original condition of strength.

Lay out a jig of planks that will accommodate the dimensions shown. For a base line make a long straight line that is parallel with the top of the fuselage from the rear to the center station. Note this base line cuts through the center of the motor mount ring. Lay out the outlines in pencil and then drive 20 penny nails all around and whenever needed to hold tubing in place.

The longerons from the mount to just back of the third station are ⅝ by 20 tubing. All tubing



Although we have never seen a landing gear with the features incorporated in this one before, it has withstood the tests of a lot of flying and no doubt is easy on the ship.

to the wheel frame. Cut these two arms off with a hacksaw as close to the crankcase as possible. The lugs are welded on in the center of the case to hold the engine to the motor bed.

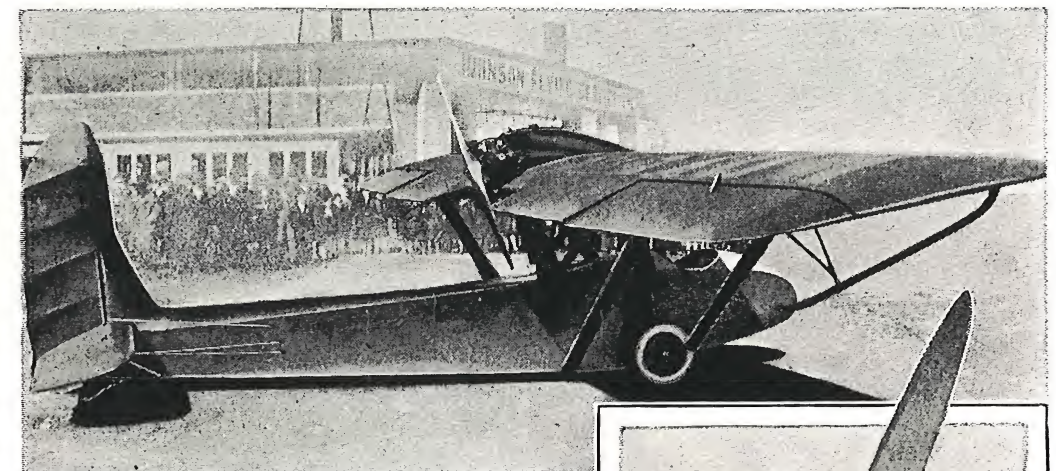
It is not amiss to offer another word here regarding the screwing of the plug onto the crankshaft. It must be brought up as tight as possible, and then a hole is drilled through the whole assembly, as shown in the drawing — through the tubing, the plug, and the end of the crankshaft. Diameter of the hole should be ⅛ in. Through this run a steel pin which should be bradded on each end after it is in place.

Arrange the throttle control in some place convenient to the pilot. This detail can well be left to your individual judgment, depending upon the particular design of your glider. All that is necessary to remember is that the throttle should be quickly accessible to the pilot when he needs it.

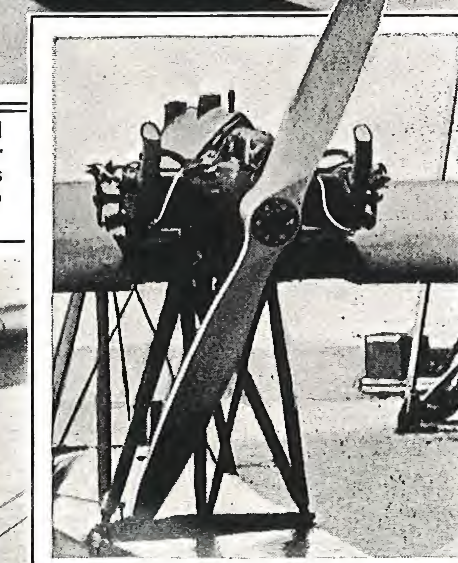
The propeller can be made of spruce or oak and should have a diameter of 3 ft., a pitch of 19 in., and should be 1 13/16 in. thick at the hub.

When cranking the motor be extremely careful, for it starts with a buzz and if you are not reasonably cautious the prop might catch your hand or arm. •••

POWER GLIDERS RIVAL LIGHT PLANES IN POPULARITY



This power glider, which was designed by Orval Snyder and E. A. Johnson of Dayton, Ohio, for sport flying, has maintained a speed of 80 miles an hour with the motor shown in the photo at the right.

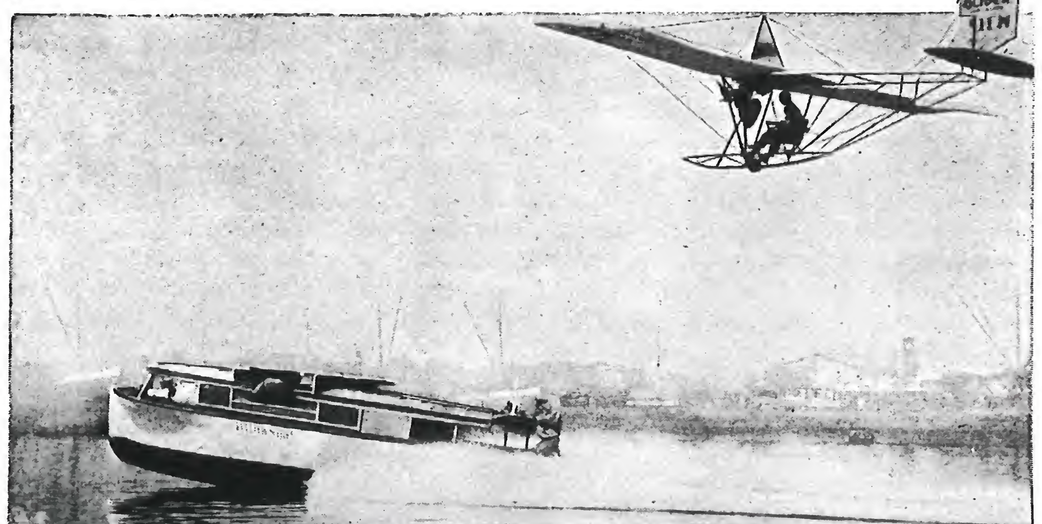


A closeup of the glider designed by the Crawford Glider Co., of Long Beach, Calif. This glider contains only a skeleton fuselage, with the pilot sitting behind the three-cylinder air-cooled motor.

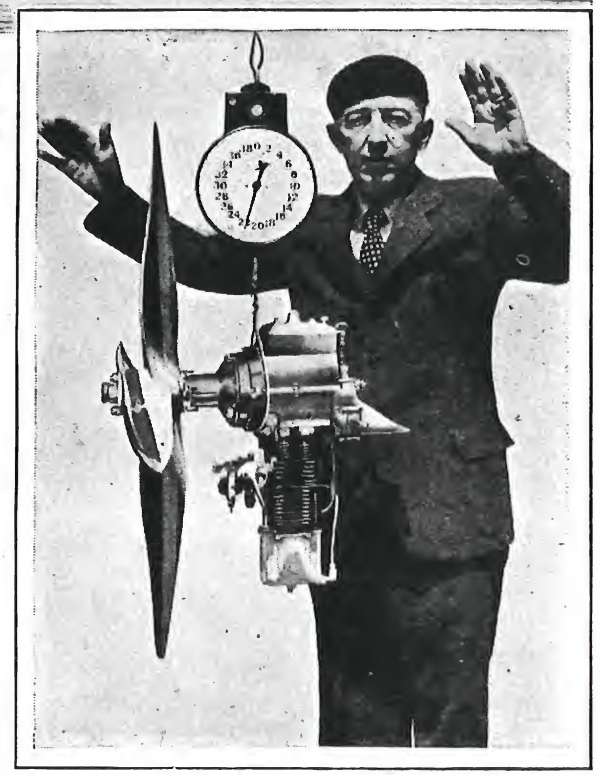
With the perfection of extremely light engines of low horsepower, lightplanes are to a large extent being supplanted by power gliders with those who fly solely for sport.

Power gliders differ from lightplanes in that they have a larger wing surface, flatter gliding angle, less maneuverability, less speed, and a much lower landing speed. Power gliders offer greater safety to the novice flyer but do not have the ability to get up and go places that the lightplanes possess.

The ship illustrated at the top of this page seems to be a compromise between a lightplane and a power glider. Possessing the large wing



This unusual photo shows Clyde Schlieper in the Crawford Power Glider just before he made a successful landing on the deck of the racing speedboat.



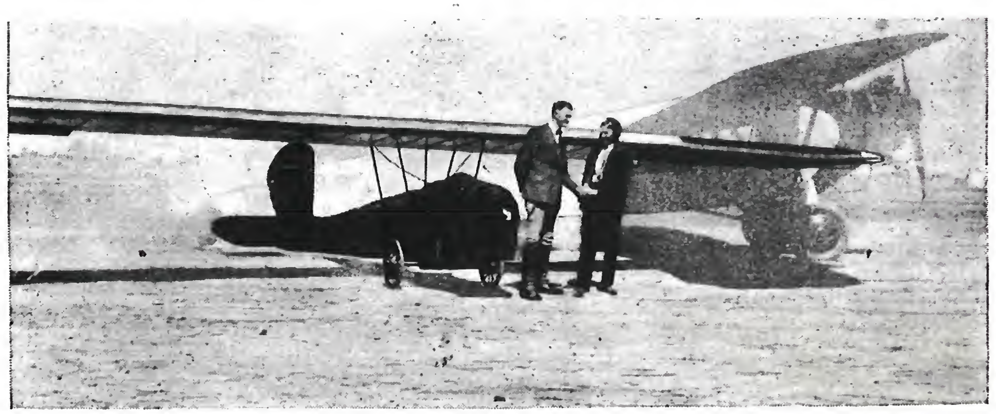
Lee Bowman, of Los Angeles, with his lightweight reciprocating glider motor which weighs but 22 pounds. This remarkable power plant produces 10 hp at 6000 rpm at which speed the prop turns 1560 rpm.

spread and control surfaces of the sailplane, it is equipped with landing wheels, streamlined fuselage and struts, and a built-in two-cylinder motor with which it has attained a speed of 80 miles an hour. The motor is mounted on the trailing edge of the wing and is of the pusher type. It was constructed and flown by Orval Snyder and E. A. Johnson of Wright Field, Dayton, Ohio.

Test Pilot Clyde Schlieper proved his skill with this type of aircraft by taking off from the deck of a speeding motor boat, flying over the water for more than a mile, and safely returning again to the deck while the boat was still in motion. The Crawford Power Glider used for this stunt is of the primary type, only a skeleton fuselage being used. A three-cylinder Anzani air-cooled motor is used for the power plant and is mounted on the framework a trifle below the leading edge of the wing.

At the right is shown a motor designed especially for use in the power glider. •••

Glider Towed 175 Miles . . .



The first "Air-Train." This is the first glider to be towed behind an airplane. Dale Drake made a flight of 175 miles from Reedley to Long Beach, Calif., making only one stop en route.

varnish and they are ready for covering.

The rudder and fin are made exactly the same, except that the leading edge of the fin is 5/16 by 20 ga. tubing, reinforced and flattened at the bottom for the bolt hole. All bolts are ¼ in. except the two that hold the elevator horn, which are 3/16.

When you get this far try your hand at covering. Use regular airplane fabric, or you can use the cloth known as "Pequot" muslin. Pull the cloth over the beams and stitch clear around the edges. Stitch the ribs with a quilt stitch three inches apart with rib cord. Put on one coat of clear dope and then apply tape on all edges and over the ribs. Put on a total of four coats of clear dope and two coats of any color you fancy of pigmented dope. The surfaces should now be drum tight and ready to go.

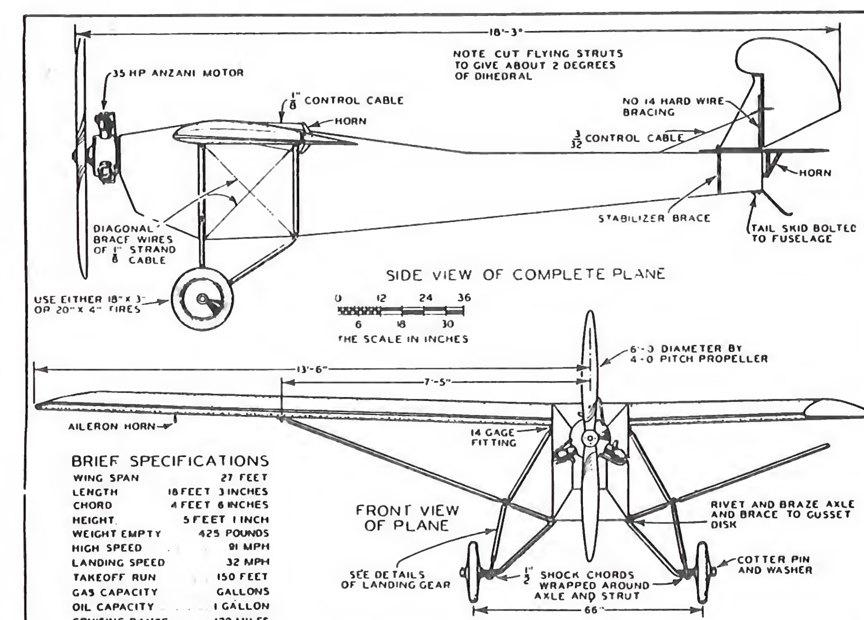
You should now know whether you want to build an airplane or not. If so, the next thing will be the wings. We think you will be surprised at the ease with which they can be built. This is mostly due to the novel rib construction. As you will note, the rib has many advantages. In the first place it can be made complete in ten minutes, which is much less time than required on the usual rib. Next, there is only one size stock to buy, ¼ by ¼ spruce, and there is no waste as all scraps can be used for bracing. There are many other advantages such as ease of repair and fitting in of reinforcement pieces where required.

The rib is the regular Clark Y, of 4½ foot chord and with the beams at 15 percent and 65 percent. Make up the complete set and save the jig for future use. This jig is simply a flat board with the rib outline drawn on it and with headless nails driven around the outline to hold the strips. Steam the front end of the ¼ by ¼ strips and put in two at the top and two at the bottom. Separate each pair slightly so that the bracing struts may be slipped between. Take a piece of stock and note where it is going to strike the cap strips. Apply glue there and then slip it between and put one 1 in. 20 ga. brad square through both halves of the cap and the strut. This makes a self-gusseted joint that is very strong and light. Fill in the whole outline, leaving the ¾ in. width slots for the beams. Let the rough ends of the bracing pieces stick through until the rib is completed and removed from the jig, when they may be trimmed with a sharp knife or saw. The completed rib will weigh 3½ ounces and you are going to enjoy making it. It just about solves the wing problem.

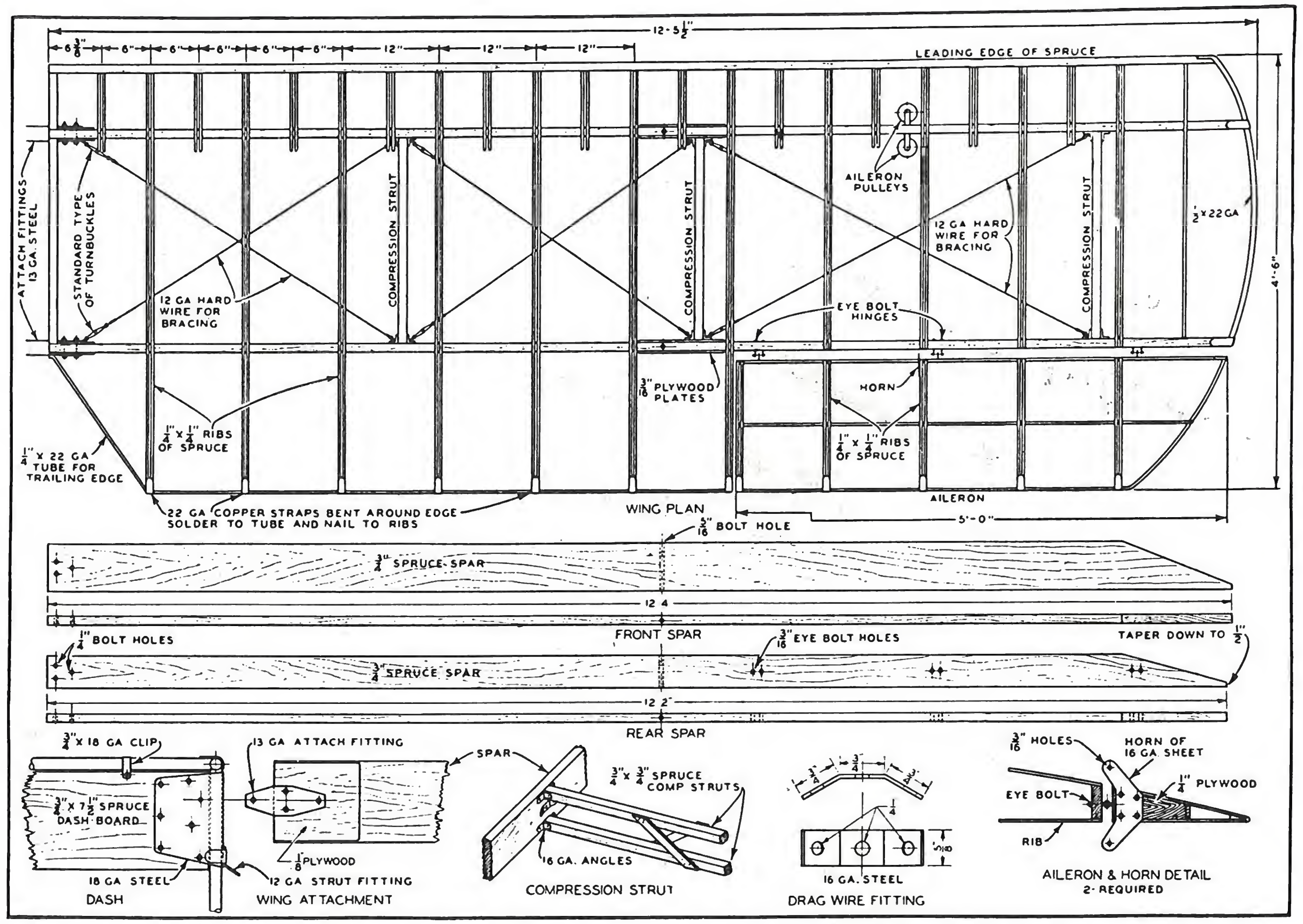
The beams are selected spruce, ¾ in. thick. The front one is 12 ft. 4 in., and the rear one 12 ft. 2 in. long. They are tapered at the outer end from the last rib to a width of ½ in. and the ends fitted to the wing tip tubing, which is ½ by 20 ga. bent as shown. The beams are fitted and beveled until they just fit the slots in the ribs. The ribs are then slipped on and spaced one foot apart. Before nailing them on, the drag bracing is to be put in. The drag struts are double, a ¾ by ¾ strut being placed at the tops and bottoms of the spars and fastened with 16 ga. steel angles and screws. The wire pulls are placed at the center of the spars, between the drag struts. A piece of ¾ spruce, 1½ in. wide and the height of the spar is placed on the backs of the spars and the ¼ bolts that hold the pulls are run through. The blocks are to keep the spars from buckling. The pulls are the usual type, 16 ga. by 1 in. wide stock.

Use 12 ga. hard wire for bracing, with standard turnbuckles. True the wing up accurately and fasten the ribs with glue and brads. It will be noted that where the wing struts come, the spars are reinforced with ⅜ plywood plates the full width of the spars and 11 in. long. The flying strut bolts are 5/16 diameter and go straight through the center of the spars. Pieces of oak or ash, not shown, are placed on top and bottom of the spars to take the strain off the bolts. These pieces are ¼ thick. Glue and nail these plates and cap pieces securely.

At the butts of the beams a piece of 1/16 plywood is glued and nailed on both sides and on these the wing attachment plates are bolted. The plates are simple pieces of 13 ga. steel. They slip over the fuselage struts and bolt to the wood crosspieces at the front and rear of the cockpit. The nosepiece, trailing edge and aileron pulleys are all standard type. The nose ribs are made in



In the old days of aviation, the days which savored of sportsmanship, one of the most popular types of plane was the little Nieuport 18 hp job which flew 60 mph. The Longster retains much of the old Nieuport. Mr. Long is to be congratulated on his design and the fine article herewith.



Solid are the spars of this little ship, and they need no routing. They are a trifle heavier than the spars in the Heath Parasol, and pretty close to as heavy as the spars in a Waco, which are 12, unrouted. The aileron attachment method is illustrated, and so is the means by which the dashboard is attached. The ailerons hinge directly on the rear spar; simplicity itself.

Co., and is 6 ft. diameter by 4 ft. pitch. The motor requires about 2¾ gallons of gas per hour, which means about 30 miles per gallon.

In proceeding with the description we are going to assume that you have some knowledge of lightplane building. No attempt will be made to go into minute details. Back issues of the *Flying Manual* have had many articles that may be turned to if in doubt. This plane weighs but 425 lbs. empty and practically any proven sport plane material or construction will be satisfactory.

When you begin actual construction our advice is that you begin with the tail surfaces. By so doing you will get an idea of what the work is like and if you spoil anything there isn't much loss. Note the drawings carefully. The stabilizer and elevator are practically identical. All beams and braces are the same size stock, ¾ by 1 in. airplane spruce. The ribs are 3/16 by ¾ spruce. The trailing and leading edges are all ¼ by 22 gauge steel, either 1025 or chrome-molybdenum.

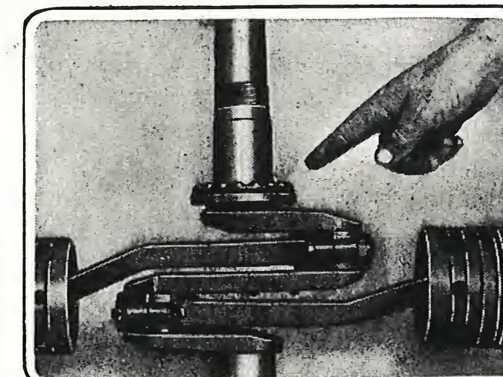
In making either part, lay out the two beams on a level floor, mark off the rib positions and put together with 20 ga. by one inch nails and casein glue. Be sure that it is all square and then put in the diagonal braces, using beveled blocks at the joints. Bring the tips of the ribs together and nail and glue. Bend the steel outline to shape and fasten it on with 22 ga. tin or copper straps at each rib and beam end. Nail the straps well and then solder them to the tubing.

The hinges are eyebolts, size 3/16, which may be had of airplane supply houses such as the Heath Airplane Co. Use large washers to keep the bolts from cutting into the wood. The blocks for the bolts in the stabilizer are simply pieces of the beam stock glued and nailed on. The center rib of the elevator takes the control horn and is filled solid with a piece of beam stock as far back as the rear beam. Make up the horn as shown and bolt it securely, and *cotter or rivet the nuts*. Don't fail to do this with every nut in the ship. Don't take chances.

The tubing in these surfaces, as well as all tubing in the ship should be soused on the inside with *hot* linseed oil to prevent rusting. All bolts should be zinc or cadmium plated aircraft bolts. Where the bolts go through the stabilizer pieces of 3/16 plywood are to be glued and nailed to raise the blocks to the level of the ribs. Give the completed frames a coat of good oil paint or spar

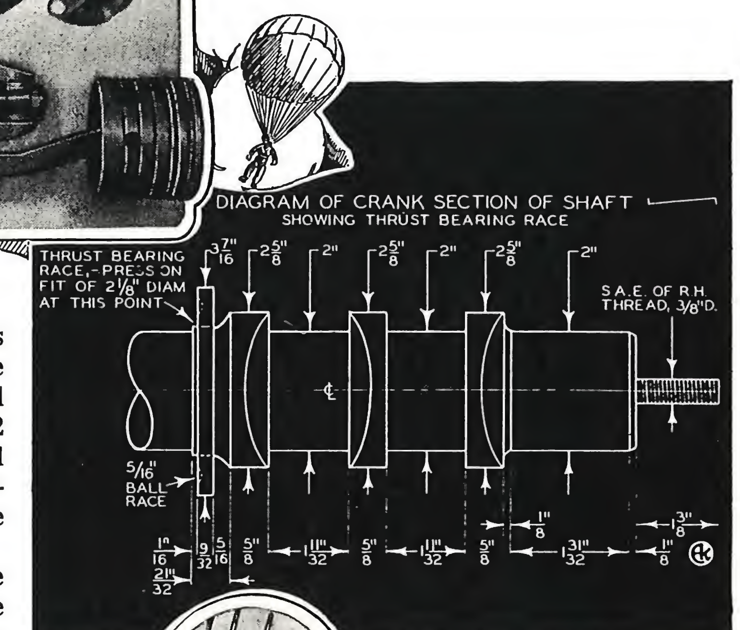
Rebuilding the Lawrence Engine

The war-surplus Lawrence 28 hp engine, owned by many lightplane fans, can now be converted to a true opposed, smooth running power plant by the use of the long promised Hickman conversion plans. Here they are!



This is the way the finished conversion will look before it is installed in the engine.

By Orville Hickman



After the war there were a good many surplus airplane motors put on the auction block by the government. Among these there was one model which sold very cheaply; namely, the Lawrence C-2 28 hp Penguin training plane motor which was used to power the clipped wing machines used to acclimate the aviators who were rushed through the ground schools of that day.

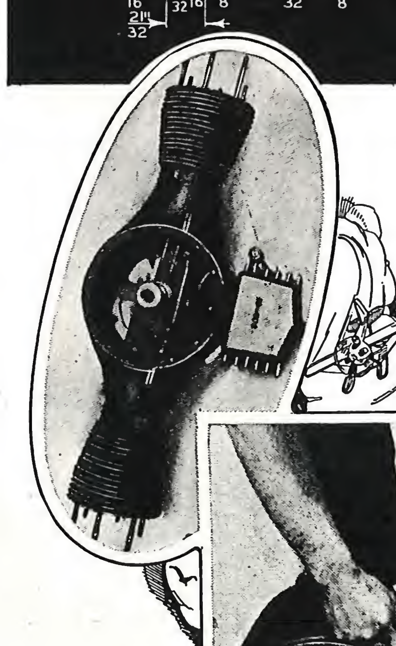
Because the machines never flew, in fact, were designed not to, the engines were built with but one throw in the crankshaft. This at their 2,000 rpm speed caused so much vibration that lightplane users, having picked up motors at anywhere from $75.00 to $125.00, found they could not use them in light 500 lb. planes without shaking the fuselage to pieces.

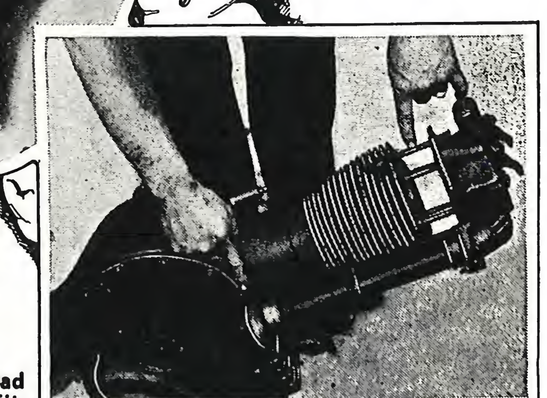
Today there are a lot of these new and unused engines available for low prices.

The two throw crankshaft can be fitted in nicely in all these motors and will not only increase the rpm's considerably, but the engine will fly smoothly, like a Bristol Cherub or a Scorpion. The chrome vanadium casting is more than amply strong, and will give good service. Cast crankshafts are nothing new — most farm engines are made with them, and I have built several Lawrence conversions that are ticking off the knots in fine style with this kind of shaft.

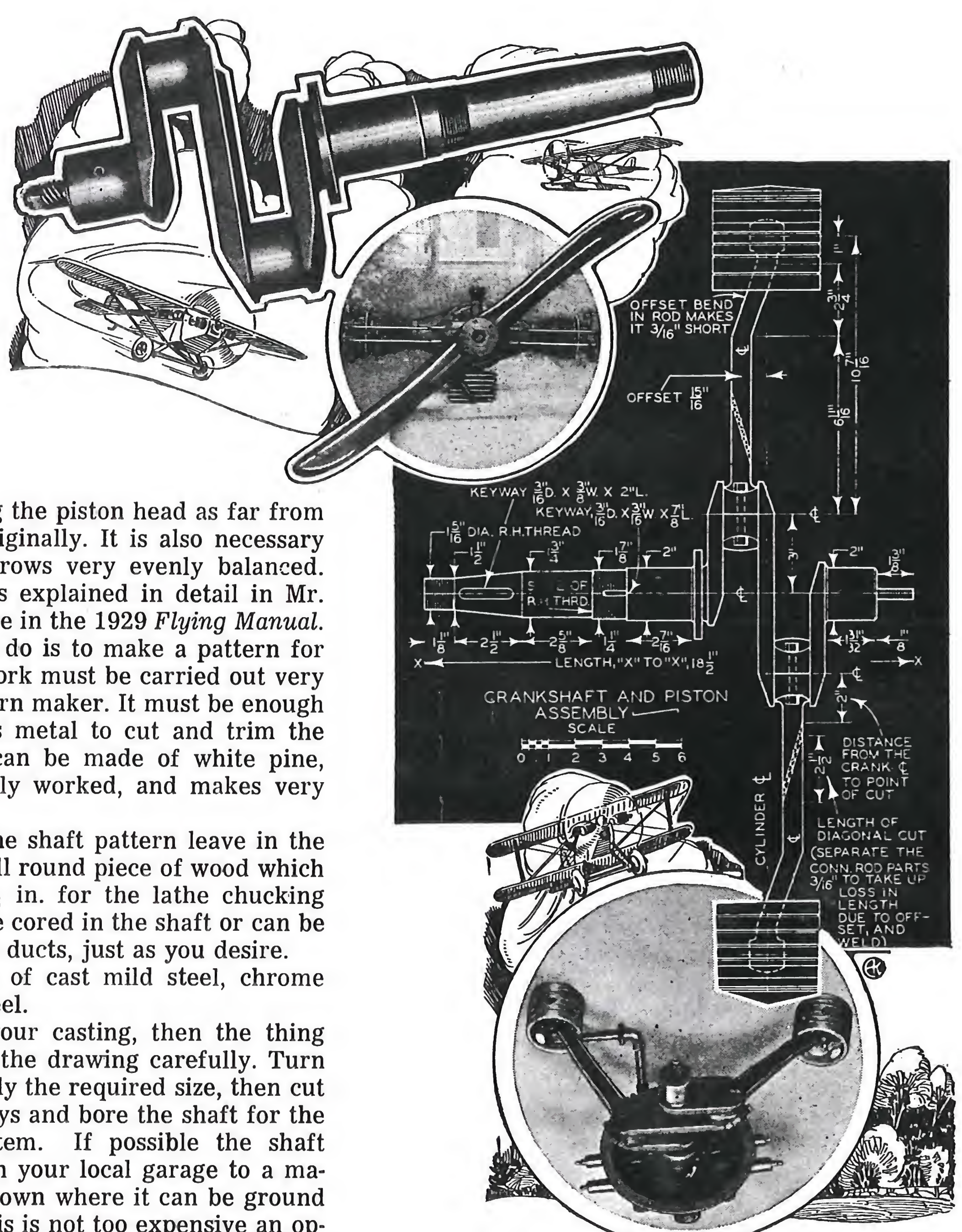
In order to make a shaft for this motor it was found necessary to put bends in the connecting rods (outboard motor practice) and to lengthen them so that the small amount of the bend was

Above you'll find a side view mechanical drawing of the Hickman crank design which will give finished measurements for the diameters and web spacings. This fits into the space occupied by the original one-throw crank and makes a true opposed motor for lightplanes.





Don't experiment with souped up piston clearances because the head must go back into its original place to allow the manifolds to fit.



taken up again, leaving the piston head as far from the crank throw as originally. It is also necessary to make the crank throws very evenly balanced. This balancing work is explained in detail in Mr. Hodgdon's motor article in the 1929 *Flying Manual.*

The first thing to do is to make a pattern for the crankshaft. This work must be carried out very carefully, or by a pattern maker. It must be enough larger so that there is metal to cut and trim the casting. The pattern can be made of white pine, which is soft and easily worked, and makes very nice patterns.

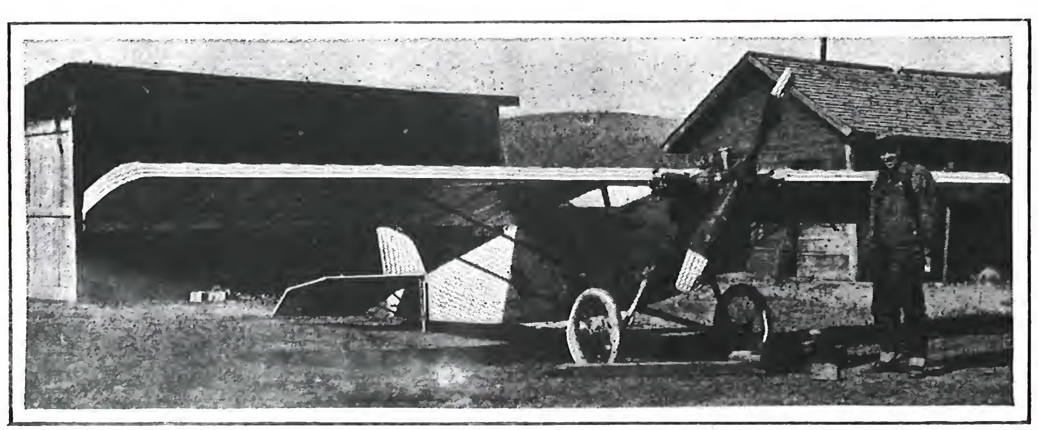
On each end of the shaft pattern leave in the center end shaft a small round piece of wood which extends for about 1½ in. for the lathe chucking operation. Holes can be cored in the shaft or can be drilled later for the oil ducts, just as you desire.

The shaft can be of cast mild steel, chrome vanadium, or nickel steel.

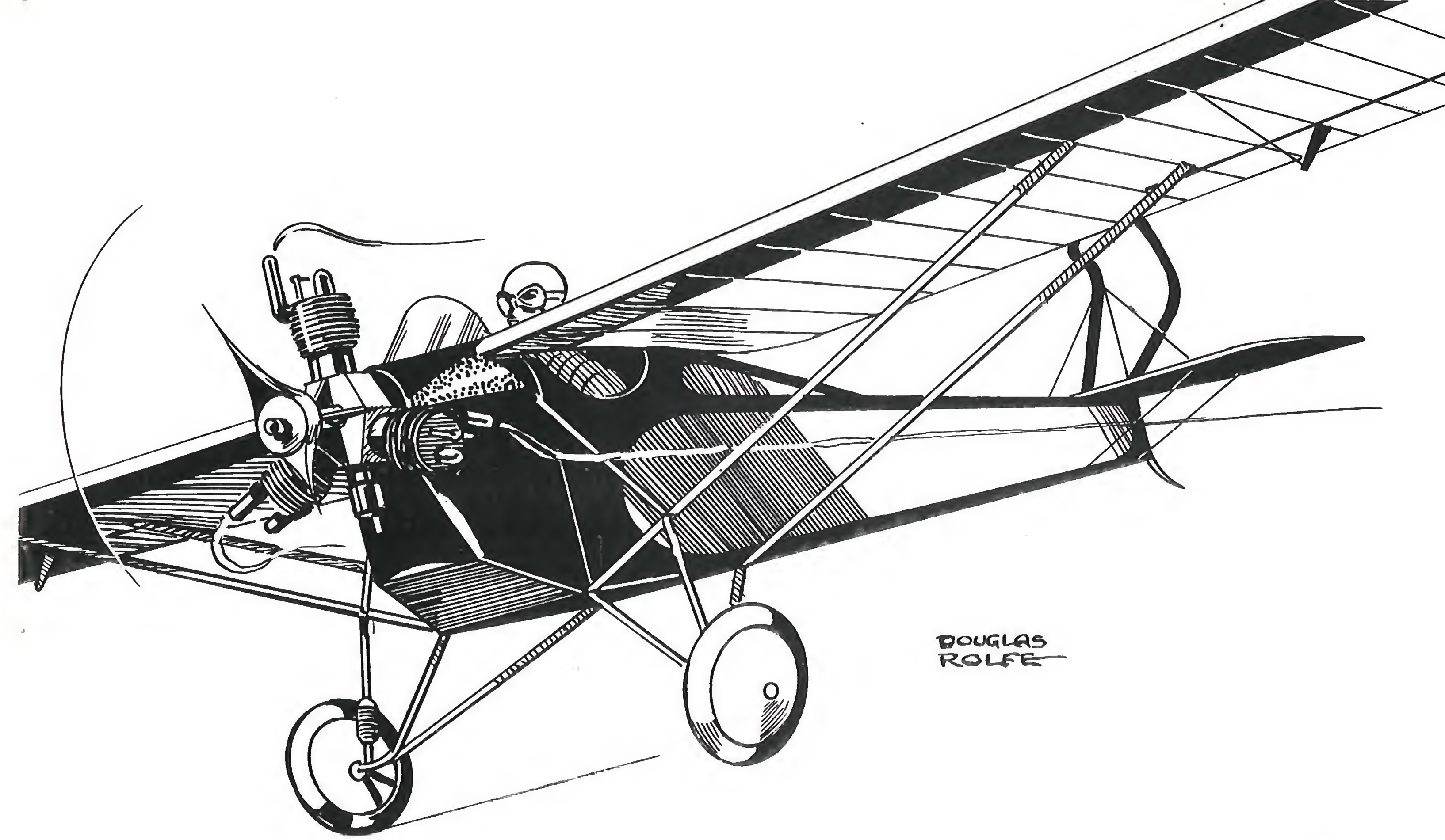
After you have your casting, then the thing to do next is to study the drawing carefully. Turn down the shaft to nearly the required size, then cut the threads and keyways and bore the shaft for the force feed oiling system. If possible the shaft should be sent through your local garage to a machine shop in a large town where it can be ground to size by grinding. This is not too expensive an operation and will be well worth the trouble it costs you.

On the plan view of the crank, though no oil

Top, the finished two-throw crank. Bottom, showing cored hollow throws for oil passages. Castings for this crank can be obtained by amateurs wanting to make their own. See article.



Here's an Alco Sportplane, plans for which were published in the 1930 edition of the Flying Manual. This ship was built by a Modern Mechanics reader from these plans. It shows the installation of the Lawrence engine which develops the usual 28 hp and gives the ship a performance somewhere between that of the old Jennies and the modern Wacos.



HOW TO BUILD THE "LONGSTER"

By Les Long

The little ship described in this article is the result of no small amount of planning and hard work. My brother and I are the proprietors of a small radio factory, and during the past ten years have had a hankering to experiment with lightplanes. We finally arranged to do this and we find it the most interesting hobby one could hope to have.

This Anzani "Longster" is the second ship built. The first one flew very well, but had some irritating habits and was finally dismantled. In designing the *Longster* much thought was given to planning a ship that would be easily, quickly and cheaply built. There are several details of construction that we believe will be of great help to sport plane builders, and which so far as we know are original with us.

As to performance, the plane has greatly exceeded our hopes. Its measured speed over a five-mile course, four times each way, is 91 mph, and the landing speed appears to be about 32 mph. The take-off run in an ordinary stubble field is never over 150 feet in still air, and in over 75 flights it has never bounced two feet off the ground in landing. However, its stability is its main feature. Three experienced test pilots flew it and each of them pronounced it the most stable ship he was ever in. To show you how it behaves, the test pilot who first flew had never even seen it before. He got in it, ran it up and down the field twice and then took it off and flew completely out of sight before bringing it back and landing it.

But listen to this — on its very next flight it was taken up by a student who had been soloed at 1½ hours, who had had but two hours in the air in his life and who hadn't flown for a year. He took it off, stayed up half an hour and landed perfectly and then flew it nearly every day for the following six weeks without the slightest trouble. After three months of flying it hasn't even a busted shock cord, although it has had two forced landings.

In looking around for a motor we decided on the 35 hp Anzani because they are fairly low priced and easy to work on. The propeller was made by the Storey

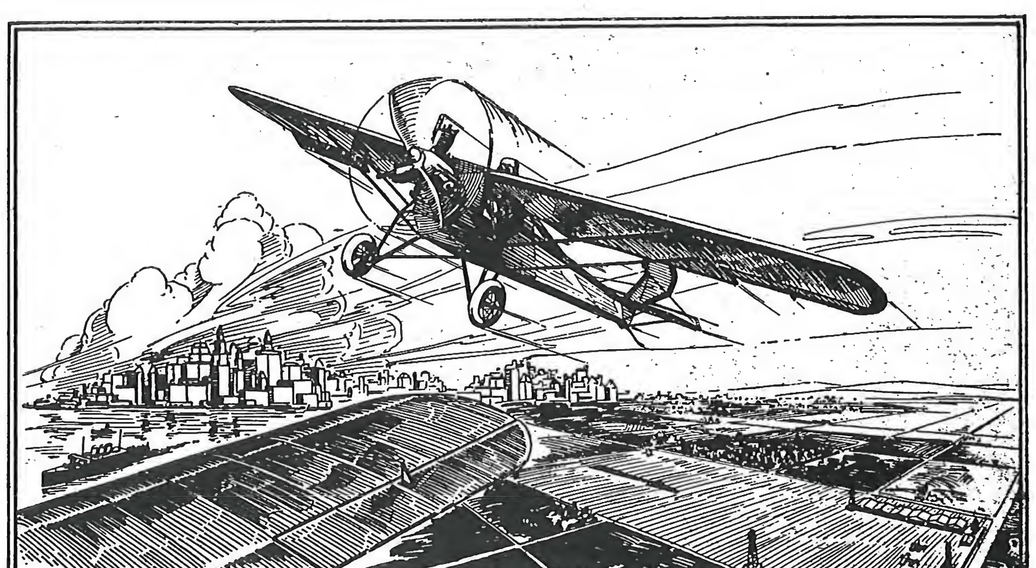
BUILDING A LIGHT AIRPLANE

Leaders in the aviation industry have almost unanimously come to the conclusion that the future of aviation depends in a large measure on the popularization of the light airplane. The reason for this conclusion is easily understood. It is prohibitively expensive for the young man of modest resources, with ambitions to become a pilot, to take his lessons at a flying school and then, having soloed, to be faced with the necessity of purchasing or renting a $10,000.00 airplane if he is to make use of his training. Before he can secure a transport pilot's license he must have built up 200 hours of flying time. For this purpose the light airplane is ideal.

Just what is a light airplane? It may be taken to mean a machine which weighs less than 500 lbs. loaded, powered by a motor of around 35 hp. Airplanes can be built within these limitations which will carry the pilot and give a performance comparable to that of most commercial ships. Light airplanes are thoroughly airworthy and are inexpensive to operate and maintain. That's why they're popular.

Such ready-built ships, however, are not on the market in great numbers. Many manufacturers have brought out light airplanes since the 1930 edition of the *Flying Manual;* there are a number of successful models on the market today. Nevertheless, young men who want to own a light airplane will naturally have different ideas as to the type of ship they prefer, and the open market is likely to offer an insufficient variety from which to pick.

That is why the editors of the *Flying and Glider Manual* have presented, in the pages which follow, plans for light airplanes of various types, ranging from sport monoplanes to seaplanes. These plans are available nowhere else — they are the best lightplane plans that are procurable today. They not only present complete plans with drawings which make their construction easy for anyone of ordinary mechanical skill, but they offer as well sufficient variety to enable the builder to choose the *one* design that fits his needs. All of the planes shown have been designed and built by flyers who know their business — whose names are synonymous with air knowledge. The plans speak for themselves. Pick the one you fancy — and go to it! •••



holes are shown, so as to avoid confusion in reading the drawing, a 3/4 or 1 in. hole is bored from the front end of the shaft X to the web behind which is the designation c-l. Then holes are bored into the webs, the cored holes plugged, and the bearing surfaces tapped where the bearing caps for the con rods are. These oil taps should be on the outside of the throw or centrifugal force will work to keep the oil from the bearing.

Next we have the connecting rods to cut and bend to shape. After bending they must be cut in two and welded again. This is a simple procedure if planned before started. Take the rod out of the piston and place in an old wrist pin. Place the pin in a vise and apply heat on the rod 1 in. from the center of the pin forward toward the connecting rod end. The best way to apply this heat is with an oxy-acetylene torch, but if this is not at hand, heat the rod in a forge to a cherry red heat and bend out to a template. This should be so that a point 3 3/4 in. from the pin is offset 15/16 from the original center.

Then it is next necessary to lengthen the rods some, because the bend we placed in them has shortened them up a bit. Cut the rod off on a 2 1/2 in. diagonal cut so as to avoid a butt weld which is not very efficient. The rod after the cut is moved just 3/16 in. apart and the gap lap welded with the acetylene torch. This part of the work must be handled by an experienced welder.

When this procedure is finished take the rods and line them up by placing them in a large vise and using a large monkey wrench. After you have them absolutely in line in all directions, dress the welded parts up.

The skirts of the pistons will have to have a small part of them removed.

After all is finished put the motor together with the utmost care, and time correctly both cams and the distributors and you will find that you have a real nice lightplane engine that weighs around 110 lbs., and develops 28-30 hp on 2,000 rpm's. •••

ON FLYING A GLIDER

There are several methods of getting a glider into the air for a flight; a number of pointers are given in the pages which follow which will help the beginner to get a conception of what the business of glider flying is all about. There are only two methods of launching, however, which have a wide acceptance. These are the shock cord or catapult method, and the auto towing method.

Launching a glider with shock cord requires the aid of a considerable ground crew. The shock cord is a rope of elastic material which is attached to a hook in the glider's nose. One or two men hold down the tail of the glider, while a group of three or four on each side of the craft move forward and outward until the rope is stretched tautly in the shape of a V. On signal the men holding down the tail release it, the launching crew runs forward, and the elastic cord hurls the glider into the air like a missile from a sling shot.

The second method, that of being towed by an automobile, is particularly useful in teaching students to become accustomed to handling the controls. This is naturally done at such low speeds that he is never in danger. Usually the beginner is towed across the field at 10 or 15 miles an hour, steering the glider with the rudder until its action becomes more or less automatic. During this time he pays no attention to the control stick, but after awhile the speed of the towing car is increased and the glider pilot is able to raise the tail of his craft off the ground. He can vary the angle of the wings, and, in fact, accustom himself to almost every maneuver except banking without leaving the ground, and traveling at a speed no greater than 20 miles an hour. Usually three or four hours is all the time required for this preliminary training.

Next the student is towed at a speed which will enable him to fly a short distance above the ground, say about 6 ft. The speed of the car regulates this height; usually the speed required is not over 30 miles an hour. In case of emergency, the glider can be landed by slowing down the tow car or tripping the tow rope, in which event the craft settles to earth of its own accord and no damage is done because of its light construction. Only after the student has thoroughly accustomed himself to the "air feel", should he ascend higher. Ascents of 300 ft. via the tow rope method have been successfully made.

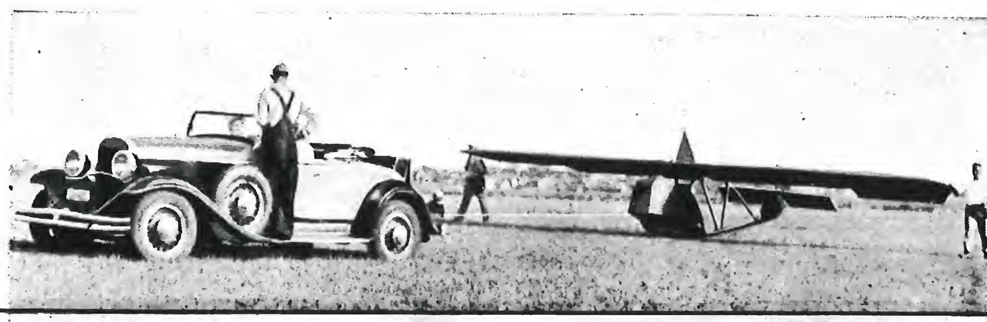
Pointers on Flying Your Glider

By Bob Gordon

Motorless gliding may be taken up either as a means of obtaining flying training or as a sport in itself. As the controls are the same in both a glider and power plane, many hours of valuable training may be obtained in a glider at small expense and with very little danger. As a sport, gliding will justify itself after the first flight, for there is a real thrill and challenge in soaring over hills and valleys, watching the ground and cloud formations, and striving to take advantage of every air current in order that the flight may be sustained a few minutes longer.

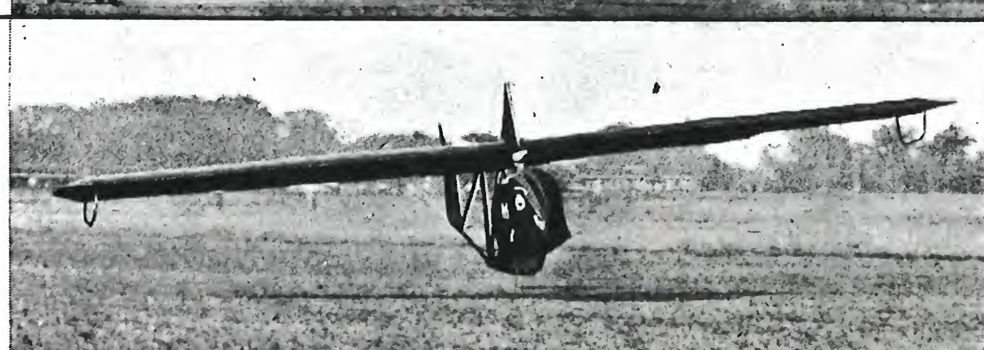
Gliding with the shock cord method of launching is no more dangerous than riding a bicycle, providing your glider is properly constructed. Of course, crashes are inevitable with the beginner, but with the light weight and sturdy construction of the modern glider, it is rarely that the pilot will emerge from the crash with even a bruise. Landings have been made in trees and against the sides of buildings without damage to the pilot.

The only real danger to be encountered is the stall. The pilot must remember that he has no power plant to pull him up, and he must depend upon rising air currents to obtain altitude. To tilt the nose of the glider sharply upward will bring about a stall and crash every time unless one is flying high enough to enable him to dive to regain flying speed, and it is seldom one will have this altitude

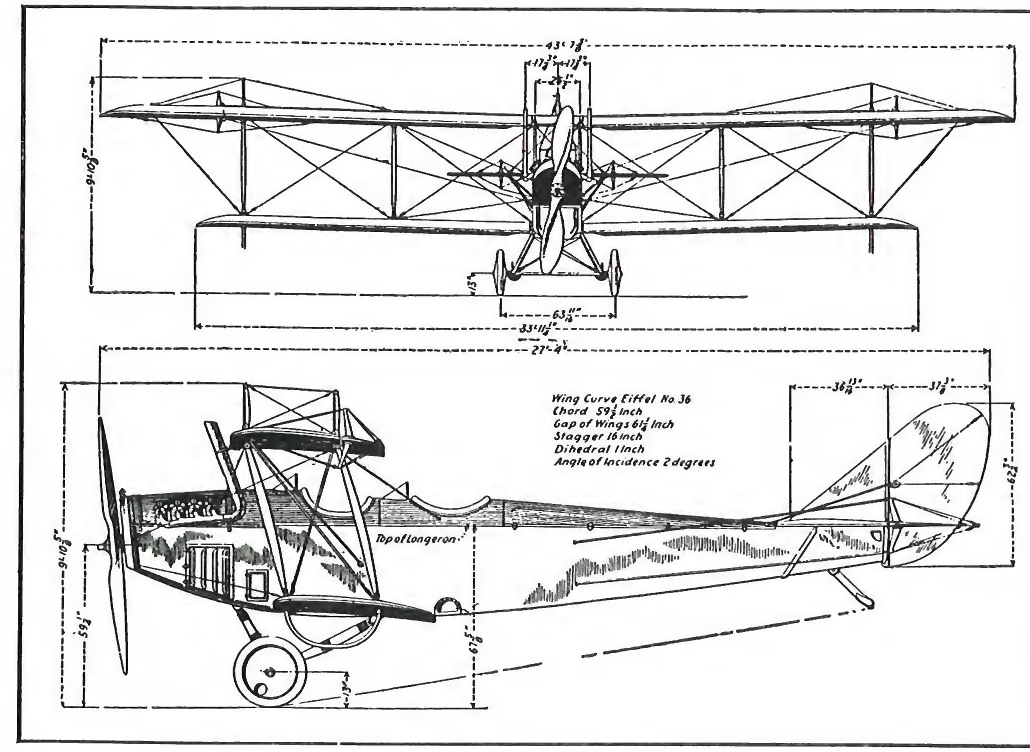


Glider and tow car ready for the start. Car was driven in second gear to insure constant acceleration. Man on running board transmitted pilot's signals to driver of car.

The glider in the air after the tow car has stopped. Photo gives a good idea of the height attained by the ship. A 500 ft. manila rope was used for towing the glider.



Pilot Gene Shank bringing the glider down for a landing. This photo was snapped a few moments after the one in the center of the page. Skids on the ends of the wings protect them from damage in the event of a rough landing. The glider settles with the grace of a sparrow landing on a wire.



A rare drawing of the Jenny showing all the major dimensions of this famous training ship. The sturdy construction, the wing runners and the braces above the wing made the Jenny popular with wing walkers who came into their own during the barnstorming days immediately after the war.

sation at the various towns near to the fields. It became as well known in those localities as the airmen themselves. Hundreds of stories were told of its wonderful feats and the name *Jenny* became a household word.

After the war our government sold its surplus *Jennys* by the hundreds. The price was so low that anyone who wished could buy them. Thus there was scarcely a town in the country which did not have at least one or more *Jennys* tethered nearby in the smoothest and largest cow pasture, ready for use when wanted.

As the years passed by the *Jennys* in the U.S. Army Air Service were rebuilt and repaired but civilian aviators either flew theirs until they fell apart for needed repairs, were cracked up too badly to be fixed, or patched them together with hay wire and fence palings. However, the *Jenny* seemed to fly along just the same. These were dark days for civilian aviators and it was the exceptional airman who had funds enough to keep his plane in first class repair. After a while the *Jenny* began to get old, get weak in the knees, show signs of its years of wear and tear and become rotted in its wooden members. Civilian *Jennys* which were still flying were sold for scrap, burned or abandoned. Even the government planes could not be economically repaired. The day was fast approaching when the *Jenny* would no longer be considered as a safe plane to fly.

That day finally came in the fall of 1927. Orders came from the War Department directing that all remaining *Jennys* be surveyed and burned.

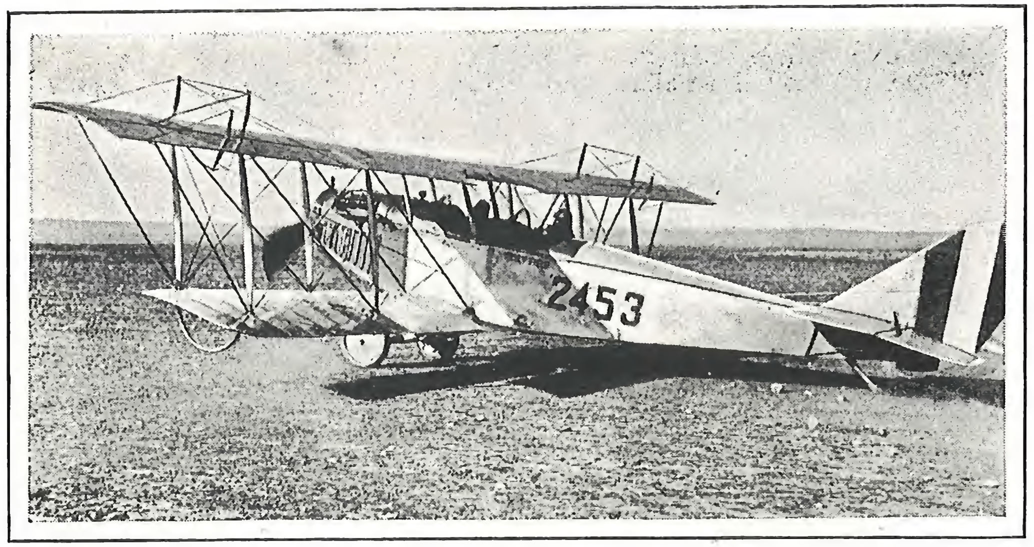
Today one sees a *Jenny* very infrequently. Its fabric is usually pieced and patched; its fuselage is warped and twisted out of shape; like as not its original wings will have been replaced by those from another kind of plane; the rudder and elevator probably have lost their shape from numerous repairs but in spite of the changes and alterations, it is still a *Jenny*. It has enough of its original earmarks left for the older airmen to stop and look it over.

"As I live, a *Jenny*. I thought that the last of them had gone the way of all good ships long ago. I'll never forget my first flight in one of those old crates. Oh boy! What a thrill!"

For some time after the war Curtiss' business consisted almost entirely of government contracts. Civilian aviation seemed to be almost at a standstill. What there was was in the hands of the demobilized army pilots who purchased *Jennys* from the government and took to barnstorming. The *Jenny* was ideally suited for this kind of flying, as it was a sturdy ship, while the wing skids and external braces over the top wing provided holds for the then popular wing walkers.

In the meantime Curtiss developed racing planes for the army and developed the *Falcon* observation plane, the *Hawk* pursuit plane and the *Condor* bomber, all of which have been standard in the Army Air Corps.

When Lindbergh's epochal flight in 1927 stimulated civilian aviation, Curtiss was ready with the *Fledgling* training ship, the *Carrier Pigeon* mail and express plane, the *Robin* cabin plane and finally the *Tanager,* which won the $100,000.00 Guggenheim prize as the safest airplane yet manufactured. • • •



This is the "JN-4D" known throughout the world as the Jenny. Practically all American war-time pilots were trained in this type of ship. Note how top wing has been cut away to secure better vision.

that all of his engines had been pushers with the propeller in the rear pushing the plane through the air. The model "J" demonstrated its superiority over previous models by capturing the American altitude record for pilot alone with a climb of 17,441 ft. The following year the model "N" came out. This plane was also a big success and jumped into the limelight by making a new altitude record for pilot and passenger with a climb of 11,960 ft.

Both the model J and the model N had good and poor flying qualities. Accordingly, Curtiss took the good points of both models and put them into a new model which he called the JN. The first *Jenny* made its appearance. She had the good flying qualities of both models and was such an immediate success that orders came pouring in from England, Russia, Spain and Italy. The *Jenny* put the Curtiss Company on the map.

In 1915 the JN-2 came out. This was followed in 1916 by the JN-3. Both had improvements over the original JN. During the year 1916 the *Jenny* received its first baptism of shot and shell in battle. The United States Army Air Service was equipped at that time with JN-3s and when Pershing went into Mexico, the *Jenny* went right along. It was fired on with machine guns and rifles and stoned but never let one of our pilots down at a point where he could not get back safely, although some of them had rather long walks.

The poor old *Jenny* did its best during that campaign but was not equal to the task imposed. The mountains were too high for it to fly over. The landing fields were in such rarefied air that the *Jenny* could scarcely leave the ground. The OX-engine struggled gamely but lost so much power at the high altitudes that it could barely drag the plane through the air. *Jenny* was given the chance to prove itself a service type of plane, a plane which could accompany an army anywhere but it was not equal to the task. Accordingly, it was sent to the rear and never again reached the front. From then on *Jenny* was classed as a training plane.

The JN-4 came out in 1917 with a few improvements over the JN-3. For the next year the models changed rapidly but in 1918 the last of the family made its appearance. The JN-4A followed the JN-4 and had a tilted engine mount. Otherwise there was no big change. Soon the JN-4B came out and gave the same performance with a level engine mount. However, in order to secure fore and aft and lateral balance, the dihedral and stagger had been changed. Attempts were made to secure better performance by using the RAF-6 wings, but that spoiled the *Jenny* and only one of that model was ever produced. The JN-4D was brought out in August, 1917. That was the real *Jenny,* the one so well known to all war-trained pilots. It was very similar to the "B" except that its wings were cut away to give better vision to pilot and passenger.

As the war continued, higher powered planes were necessary for radio, gunnery and bombing training and night flying. Then it was that the JN-4H made its appearance. It was the same JN-4 with a Hispano Suiza 150 hp engine installed instead of the OX-5. Ailerons were put on both upper and lower wings and a balanced rudder installed and the plane immediately became the JN-6H. There were no other changes made in the airplane proper so the 6H was the last of the family. However, changes were made in installations for training and these models were identified by adding another letter such as JN-6HO for observation, R for radio, P for photographic and G for gunnery.

The reputation of the *Jenny* as a training plane spread so fast and the demand for the planes became so great that the Curtiss Company could not even attempt to bring out planes fast enough. Before we entered the war the Canadians were building Canadian *Jennys* which were immediately called *Canucks.* Another factory was started in England. In the United States factories were started in Springfield, Mass., St. Louis, Mo., San Francisco, Sacramento and Redwood City, Calif.

The *Jenny* was used at over 30 aviation fields in the United States and became a topic of conver-

unless he has been towed by an airplane.

The glider should be launched into the wind the first few times from level ground, and when one has gotten the feel of the controls he can make longer flights from a hillside. To launch by the shock cord method, the only method we can recommen to beginners, the pilot takes his place on the seat and adjusts his safety belt. Then while two or three "anchor" men hold back on the stern rope, the launching crew grasps both ends of the shock cord and runs forward into the wind until the stretched cord forms a narrow "V." At the command of the pilot the anchor men release their hold and the glider is snapped into the air in much the same manner as a stone is propelled from a sling shot.

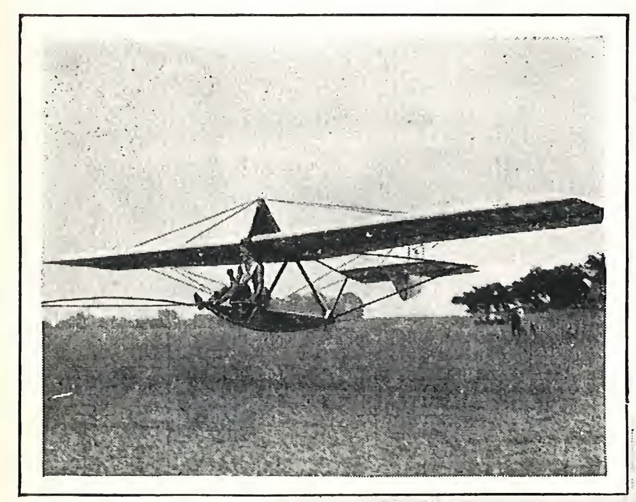
Once launched, the glider soars because of its light weight and because the very high lift section of the wing gives it a very flat glide with a stalling speed of between 8 and 10 miles an hour. Against a 10 mile wind the glider should attain an altitude of about 50 ft. when launched. It is then up to the pilot to regulate his glide to take advantage of every wind current.

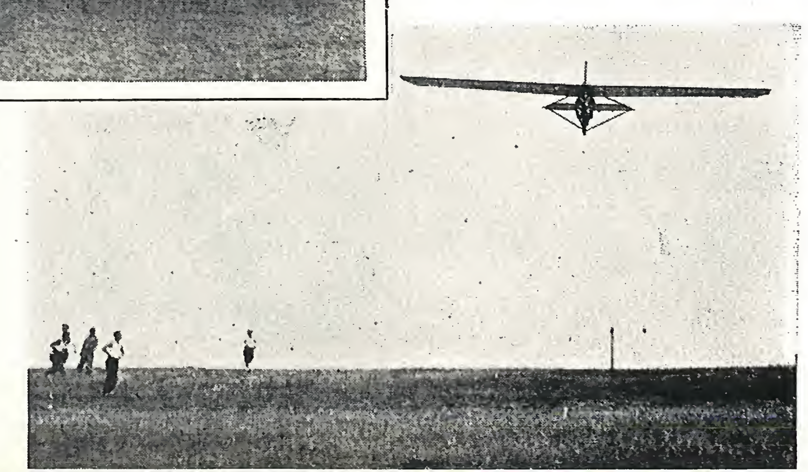
If launched into the wind from the side of a hill, rising air currents will carry the glider aloft and permit it to gain altitude. By watching the topography of the ground and the cloud formations overhead, the pilot may pick the spots where the currents will be to his advantage, and may dive from one rising current to another.

Favorable currents will be found on the windward side of a hill or where the air is heated, as over a dried field, sand, road, or town. On a warm, sunny day the currents will be stronger than in cloudy weather. Rising air currents will also be found directly under high cumulus clouds. Cliffs and hills that lie at right angles to the prevailing wind provide the best sites for gliding.

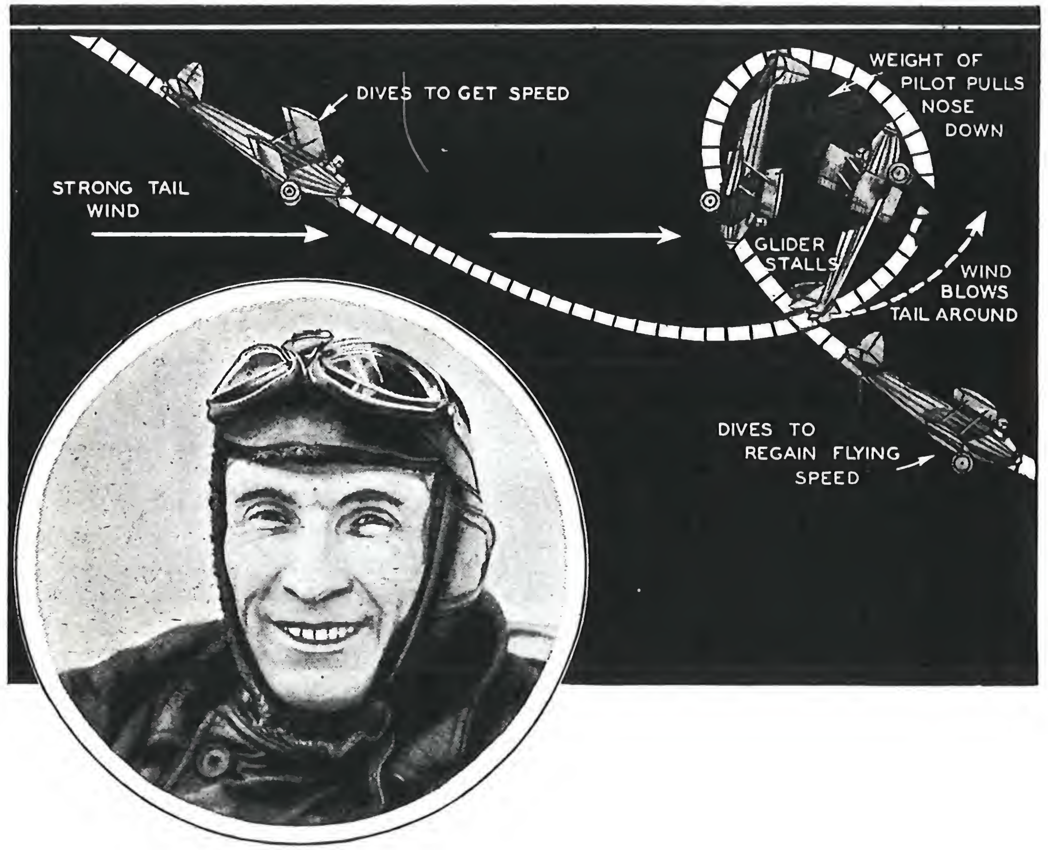
Descending air currents will always be found past the crest on the lee side of a hill, over green fields and bodies of water and over forests. Rising air currents will be scarce if the sky is darkened by black clouds. • • •

Right — With the student in the pilot's seat, the instructor gives a few pointers on manipulating the controls. At the lower right the glider is faced into the wind, anchor men hold the stern rope while other men run forward until the shock cord is stretched. At command the stern rope is released and the glider takes the air.





The glider is shown left above as it takes the air immediately after the stern rope is released. When the stretch of the elastic shock cord has been taken up the cord will easily disengage itself from the hook. This is the critical stage of the glide and the pilot must remember not to tilt the nose upward, as this is liable to cause a stall, from which a crash may result. Altitude must be attained by wind current.



By Ed Heath
Father of American Lightplanes

LOOPING THE LOOP IN A GLIDER

The impossible has been accomplished again! To Ed Heath, America's pioneer in designing, building and piloting lightplanes, goes the honor of first looping the loop in a motorless glider. How this thrilling stunt is accomplished is described here by the designer of the Baby Bullet.

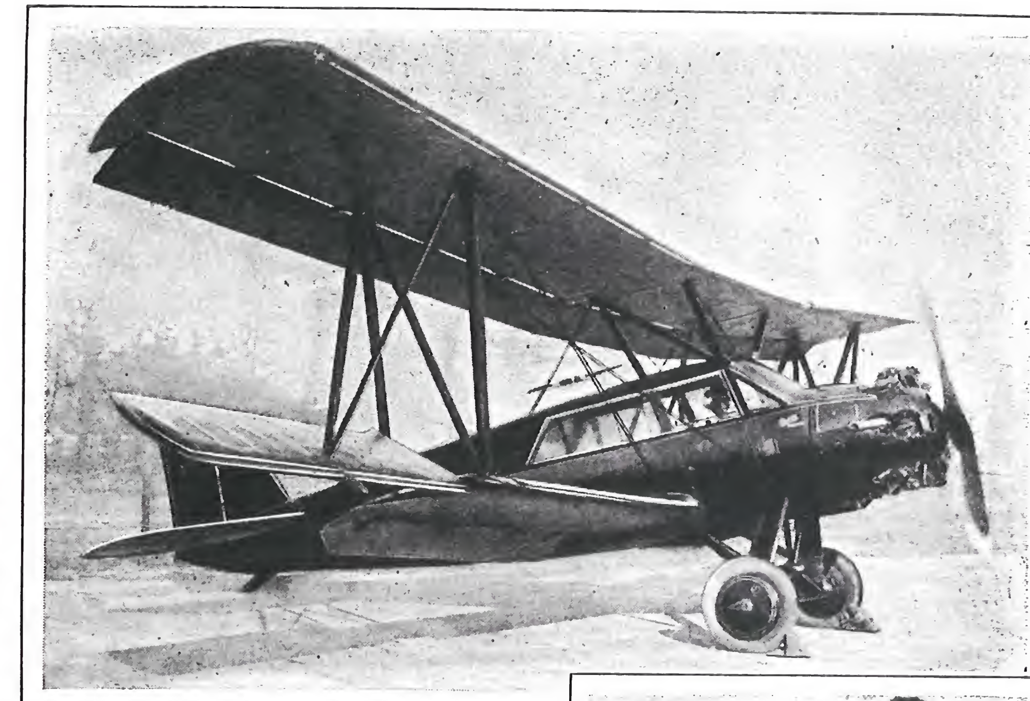
Most all pilots who have had considerable air time realize that an airplane traveling close to the ground down wind can be put into a vertical bank and face about into the wind without loss of altitude. They very early in their experiences also found out that it was impossible to reverse this condition without fatal results. That is to say the plane cannot be flown into the wind, then quickly turn with the wind close to the ground. It is because of this factor that so many accidents occur from pilots attempting to turn back to the field after the motor has given trouble, whereas they could have landed safely on bad ground dead ahead into the wind.

This same condition prevails at any altitude although it is not noticed except when close to the ground. This may be readily proven by taking an airplane to a height of 1,000 or 2,000 ft., flying it horizontally down wind for some distance without gaining altitude and reading the altimeter carefully. Then making a quick vertical bank into the wind it will be noted that the altimeter will show no loss of altitude.

Reversing this condition, that is, by flying into the wind and reading the altimeter carefully the pilot will then find by making a vertical turn back down wind that the plane has a marked tendency to spin and at best will dive before it can again be flown horizontally. Now reading the altimeter, a loss of 400 to 500 ft. will be noticed, this varying according to the wind velocity as well as the suddenness of the turn. It is this wind force that can be used to hinder or help the pilot in flight. It was this wind force that was utilized in looping the glider.

Unlike an airplane the glider stalls almost instantly when not kept in a normal glide or when the tow rope slackens. This is due to the fact that the resistance of the glider is comparatively high in proportion to its weight.

You can visualize this best by towing a piece of paper and suddenly slackening the string. It does not keep on traveling but stops almost instantly. Bearing in mind these laws it is impossible to loop a glider in still air, as no matter how far you dive it will only obtain a speed at which acceleration of



The Tanager with which the Curtiss Aeroplane Co. won the $100,000 Guggenheim Safety Prize. The floating ailerons, full length wing flaps and automatic wing slots are evident here.

Glenn Curtiss and Charles Lindbergh just before taking off on a flight from Miami to Havana.

but in 1911 discontinued contest flying and turned his entire attention to building planes and motors. Then in 1914 came the World War and the combatants needed planes. The British government approached him with a large order and advanced funds for enlarging his plant. Curtiss turned out thousands of planes from then until the Armistice was signed in 1918.

Of all the airplanes produced during the World War there was none so well known, so universally used as the Curtiss *Jenny*. Over 95 percent of American trained aviators were instructed on the *Jenny*. Some 10,000 pilots were trained on the *Jenny* in the United States alone. The correct name of the *Jenny* was Curtiss airplane model JN but the model designation invited the nickname *Jenny*. It was so christened by the first student aviator and remained *Jenny* for the rest of its life.

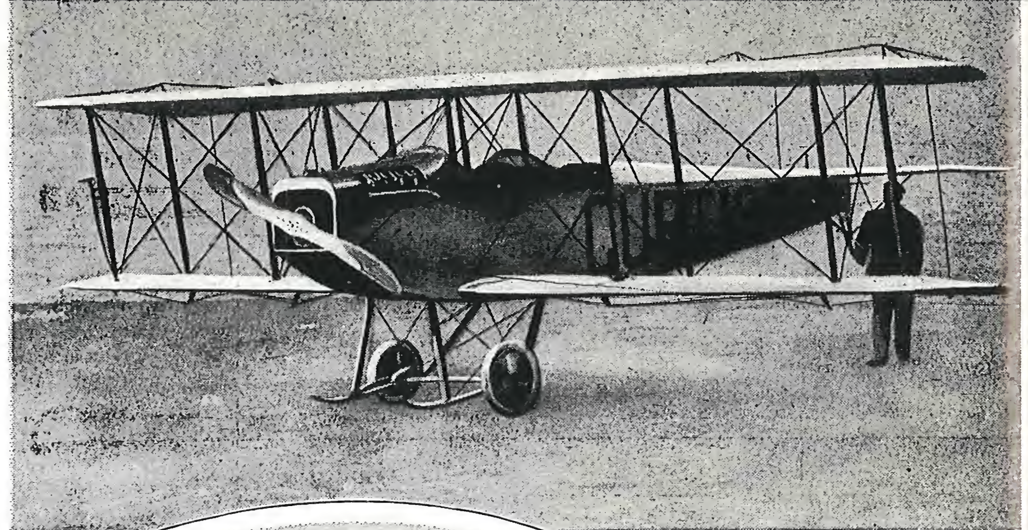
The war-trained pilots were not interested from whence came *Jenny* nor cared what the future had in store for her. Most of these pilots considered the *Jenny* as merely the means to an end; a bridge across the gap which separated a peaceful existence on the ground in the United States from thrilling aerial combats in the skies of Europe. It mattered little whether their training plane was a JN-4A or a JN-6H. The only important thing was to learn to fly and that as quickly as possible.

The development of airplanes always follows very closely that of engines. The development of Curtiss planes was no exception to this rule. His first motorcycle engine had one cylinder and developed but 3 hp. The engine which he used at Ormond Beach had 8 cylinders and developed 30 hp. In between the two were a 2-cylinder and a 4-cylinder engine. Curtiss 1908 airplane was powered by a 4-cylinder engine which developed 50 hp. The 1909 Rheims racer was equipped with a model "L" engine. It had 8 cylinders and produced 80 hp.

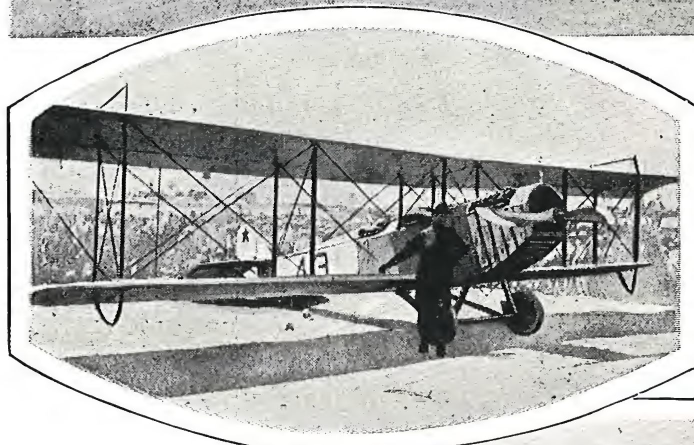
The continuous development in power of Curtiss engines can be seen from the following:

Model	Date	Number Cylinders	HP	Weight	RPM
B-8	1905	8	40	150	....
E-4	1908	4	50	250	....
E-8	1909	8	100	350	...
L	1909	8	80	285	....
O	1910	8	60	285	1350
OX	1912	8	75	325	1450
OX-2	1915	8	80	385	1500
OX-5	1916	8	90	390	1500
OXX	1916	8	100	401	1500

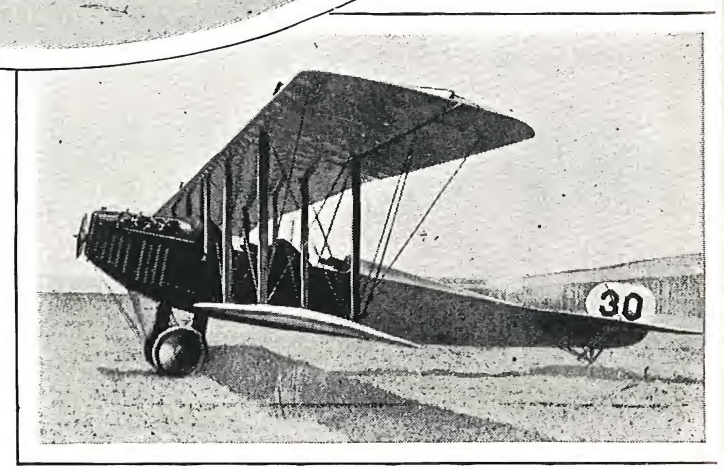
Curtiss brought out his first tractor type airplane in 1912 and called it model "J." Prior to



This is the "JN" produced in 1914. The fuselage has been covered, the landing gear changed, and it begins to look like the later Jenny models.



Lieut. H. A. Dargue standing beside his "JN-3" at Chihuahua, Mexico, in 1916 during the Pershing Expedition after the Villa raid.



In the "JN-2", above, the familiar Jenny cowling became apparent.

gine that would run two hours without interruption. That was a large order for that time, but Curtiss designed an air-cooled engine that was entirely satisfactory and the dirigible was accepted in 1905.

It was in this year that Curtiss met Dr. Alexander Graham Bell, the inventor of the telephone. Bell had been experimenting with kites and wondered if one of Curtiss' light motors would enable them to fly. This chat with Bell started Curtiss' interest in airplanes, and two years later Mrs. Bell financed the Aerial Experimental Association composed of Curtiss, Lieutenant Thomas E. Selfridge (the first man to be killed in an airplane accident), F. W. Baldwin, and J. A. D. McCurdy. The latter were two young Canadians who had only recently received their engineering degree.

It was agreed that each of the four men should have the final say in constructing four planes. The first of these, the Selfridge plane, flew 300 ft. in March, 1908, but crashed at the end of the journey. Baldwin's plane, the *White Wing,* with Curtiss at the controls, flew 1,017 ft. in 19 seconds and made a graceful landing.

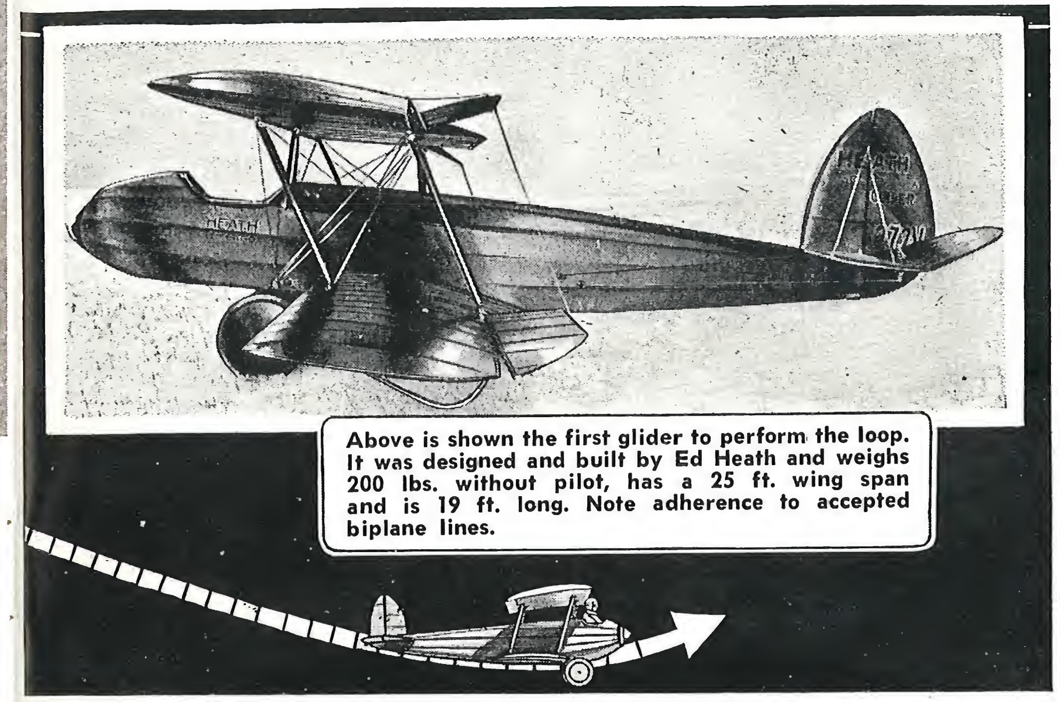
Then came the third plane. The first Curtiss airplane ever built—the *June Bug.* From the first moment its propeller pushed it down the field it flew as a thing at home in the air. It was so successful that the association decided to enter it for the Scientific American Trophy for the first straight-away flight of one kilometer. Curtiss not only won the trophy that year but won it in the next two years and retained permanent possession of the award. The fourth plane of the series, McCurdy's *Silver Dart,* was completed and made 200 flights totaling over 2,000 miles.

While engaged in demonstration flights at New York in 1909 Curtiss approached the Aero Club of America with the request that he be permitted to try for the Gordon Bennett Cup at Rheims, France. The members were enthusiastic. "Fine," they said. "Where's your speedy plane?"

"Here," said Curtiss, pointing to his head.

They were amazed and angry. Here it was past the middle of July and the races in France would start on August 22. And Curtiss had not even started to build his plane. But Curtiss built the plane, went to France without testing it, and won the trophy with a speed of 46.5 miles an hour. He became an international hero at once.

Curtiss continued as the outstanding prize-winner and record-setter during the next two years,



Above is shown the first glider to perform the loop. It was designed and built by Ed Heath and weighs 200 lbs. without pilot, has a 25 ft. wing span and is 19 ft. long. Note adherence to accepted biplane lines.

Diagram (left) shows the mechanics of the glider loop. With a strong tail wind the pilot dives to get up speed. Pulling the stick back sharply brings the nose up and stalls the glider, which is then pulled over backward by the weight of the pilot. Insert shows Ed Heath, the first to perform the loop in a motorless glider.

gravity is balanced by the resistance of the plane and the minute the plane is pulled up from the dive it is in a stall. Therefore, to loop a glider, it is essential that a high wind prevail and that the glider be traveling down wind.

The speed of the wind must exceed the flying speed of the glider. This means that the glider has a rolling moment or what we may say a traveling speed in relation to the earth at least twice that which is required to keep the glider in the air. In this condition the glider may be suddenly pulled upward. It is now in a vertical position and lost its flying speed.

The only concentrated mass or weight to the glider is the man. With this mass at the top the tail is then swept on and out from under the glider. This rotates the nose in the direction of the wind and as the glider noses further over on its back it is heading into the wind and again assumes flying speed although it has lost rolling moment. As the wind is in excess of that required for normal flight it has flying speed, therefore the controls are completely affected and a perfect loop can be made.

ADVENTURES OF A GLIDER BUILDER

By Frank Kelsey

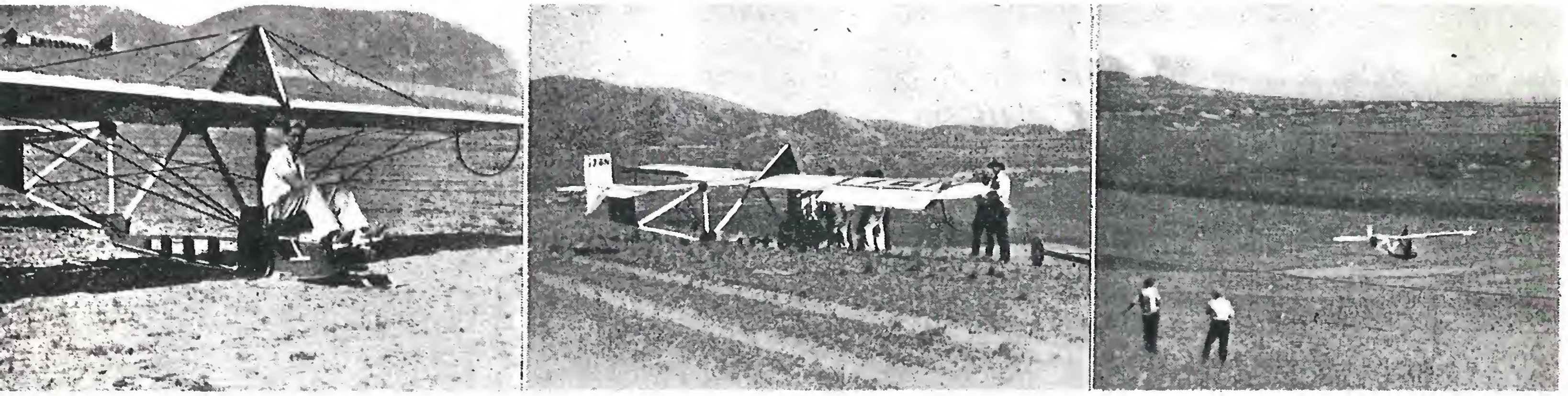
Gliding is great sport — I know, because I've built one and discovered that there's no other sport that has quite the same zest as sailing through the sky on wings that you've built for yourself.

To be exact, I have built two gliders. A friend of mine helped me build the first one. In Salt Lake City, my home town, there were no gliders or glider clubs where a completed ship could be inspected, and consequently we built the first design that we could secure plans for. This happened to be a secondary training glider with a 30 ft. cantilever wing. We located a supply of spruce and set to work.

The fuselage was completed without difficulty, but when we started the wings our troubles began. The spars were of box type and on assembling the wings on the fuselage the tips drooped until they nearly touched the ground. To overcome this we divided the wing and braced it in a manner similar to the Northrop glider.

As the ship neared completion we began to look around for a place to fly the plane, and as the University of Utah had been flying a glider at a point 25 miles south of Salt Lake our choice centered there. We set out on Labor Day with our glider stowed on a truck. The glider was assembled in a pouring rain and it looked as if our flying was over for the day, but the downpour soon stopped.

Our launching methods were rather crude, as we had no elastic shock cord and merely held the wing tips while we ran down hill until the ship left



From left to right, we have: Frank Kelsey at the stick of his glider; the glider ready to be launched; a view of the glider just after launching, at about 20 ft. altitude.

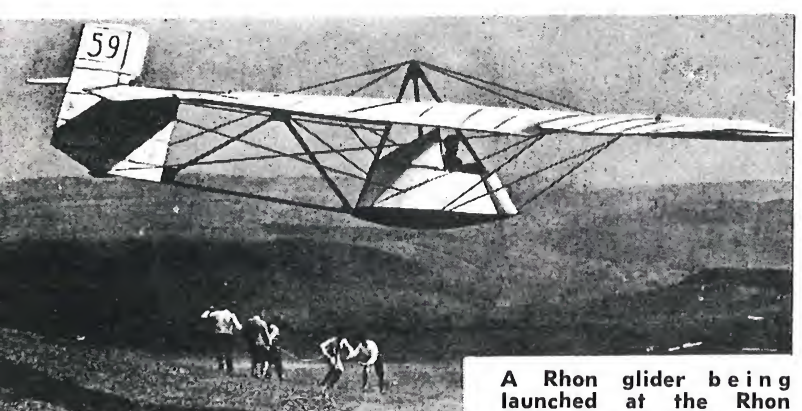
Left photo—the end of a perfect flight. Center—"Goin' to get it"; right—walking back from an airplane ride.

the ground. We got several good flights by this method, but being inexperienced we soon came to grief when a hard landing bent the steel axle of the landing gear. Repairs were made, but after two more flights a crosswind start threw up a wing and a vicious side slip ended in a crash that tore off the landing gear and smashed the tail assembly.

After this mishap we decided that the secondary plane was not designed for crash landings, so familiar to every glider enthusiast. We decided to build a primary ship of strong, heavy type, and upon locating the plans for the Northrop glider in *Modern Mechanics* and the 1930 *Flying Manual,* began work. At this point my friend had to give up his share in the enterprise when school demanded all his spare time, so I continued the making of fittings, ribs, and other details. The ship began to take shape and was finished after several months, but bad weather delayed its test flights. During this time several pilots and mechanics from the local airport inspected the glider and called it a fine ship which should fly excellently.

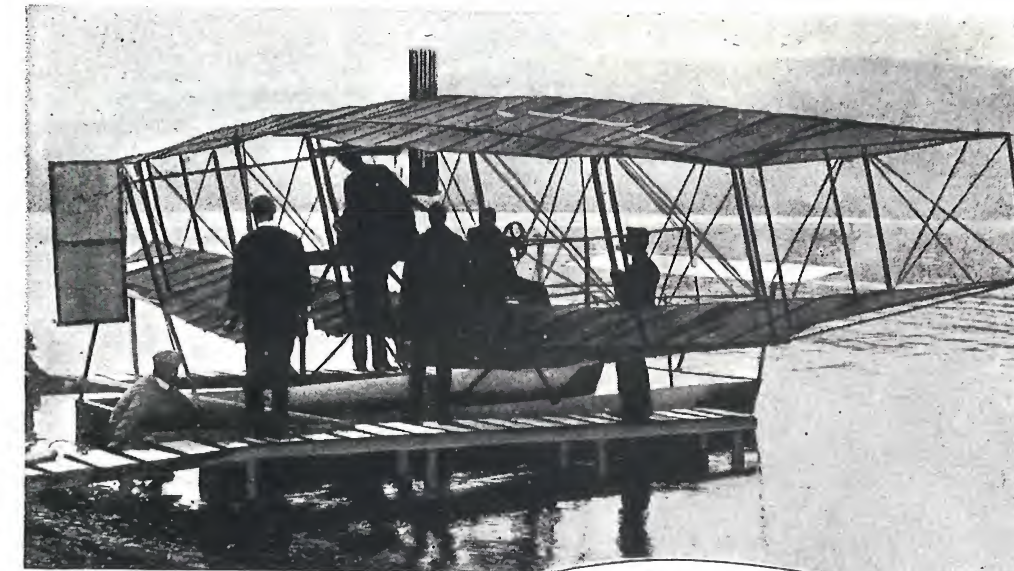
April found us at the point in the mountains where we had flown the first glider. The weather was clear, but the wind was not blowing very hard. Dave Reese, a co-pilot for Boeing, tested the ship and on the first flight of both pilot and glider, a 35 second flight was obtained from a 150 ft. hill. This was accomplished in a 20 mile wind. As the wind died down, several flights of from 30 down to 15 seconds were made without trouble.

As the glider was launched with an ordinary manila rope and not the usual shock cord, this was very good for a ship weighing 170 lbs., piloted by a man who tipped the scales at 160. The hills from which we did our flying are good and a camp will likely be established there. •••



A Rhon glider being launched at the Rhon Glider School of Germany on a flight which extended 40 miles.

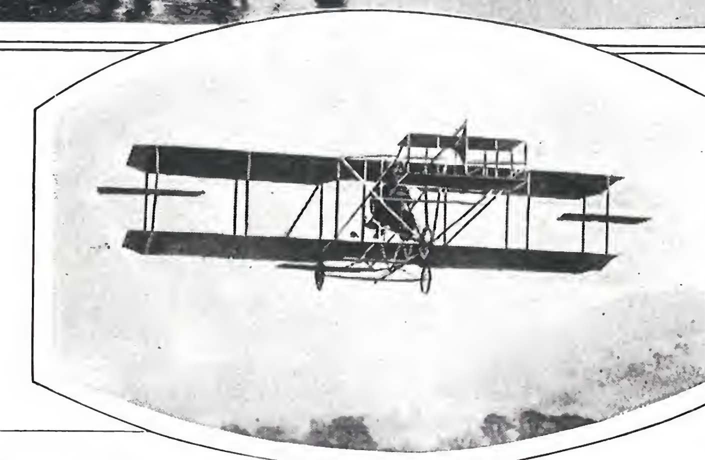
William Van Dusen landing on the water in his motorless plane which is fitted with pontoons.



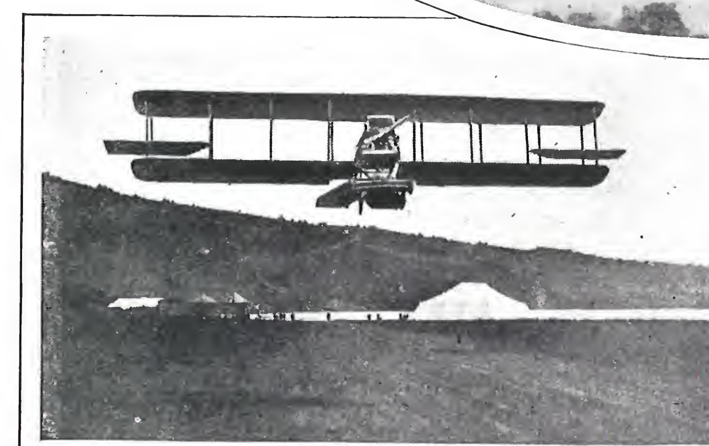
The famous "June Bug", fitted with floats and rechristened the "Leon", being tried out in Dec., 1908.

By Major H. H. Arnold and Bob Gordon

AND THE JENNY



The Gordon Bennett Racer in which Curtiss won the airplane speed race at Rheims, France, on August 29, 1908.



This 1912 Model "J" was the first tractor biplane built by Curtiss and is the forerunner of the famous Jenny. The framework of the fuselage was not covered and interplane ailerons were retained.

was created for his motors and Curtiss found himself doing a rushing business.

At this time he abandoned bicycle contests and turned his attention to motorcycle racing. At this he attained world-wide fame, establishing in 1906 at Ormond Beach, Fla., the world's speed record for the mile which stood for several years. His time for the mile was 26.4 seconds, which then was the fastest ever traveled by man.

Curtiss' first contact with aviation came in 1902, when Thomas Baldwin, the famous balloonist who was at that time building his since famous *California Arrow,* entered the little Hammondsport bicycle shop and ordered a Curtiss motor for his dirigible. For the next few years Curtiss divided his time between building motors for Baldwin and other balloonists, filling orders for his motorcycles, and racing his own machines. The climax came when Baldwin constructed the first army dirigible. The government's specifications demanded an en-

Glenn Curtiss demonstrating the military advantages of the airplane.

PIONEERS OF AVIATION--CURTISS

Glenn Curtiss, the man who contributed more to the development of aviation than any other individual, has passed on, but the aileron, the seaplane, landing wheels, the OX-5 engine, the Jenny, Falcon, Condor, Hawk and Tanager are all monuments to his memory.

With the recent death of Glenn Hammond Curtiss, aviation has lost, next to the Wright brothers, the foremost pioneer in the development of the airplane. The Wrights, who solved the problem of flight, will always stand above everyone else, but in developing the airplane, extending its field of usefulness, and demonstrating its capacity, Curtiss has set the pace.

Glen Curtiss was born at Hammondsport, N.Y., a little town at the southern end of Lake Keuka, on May 21, 1878. The only formal education he obtained was from the village schoolhouse, where he showed a marked ability for arithmetic. He was forced to leave school at an early age, owing to the death of his father, and help eke out the family income by selling papers and doing other odd jobs.

When he was twelve years of age the family moved to Rochester, where Glenn worked in the Eastman Kodak plant. Five years later he returned to Hammondsport where he worked for a local photographer and later for a bicycle merchant. In 1900 he set up in business for himself in a tiny bicycle shop.

But the name of Curtiss began to be known even before he started in business for himself. Three years before this he entered in a local bicycle race and won. This led to other races and other victories, and by the time he had become of age, Glenn was known throughout New York and the neighboring states as not only a star on the wheel but as a genius in building his own bicycles for racing.

Curtiss' real ability as a mechanic became evident soon after he went into business for himself. His former employer, who was growing old, found it increasingly difficult to push his bicycle over the vine-clad hills around Lake Keuka, so Curtiss decided that what was needed was a gasoline motor, powerful enough yet light enough to propel a bicycle. As no such motor was then available, he decided to build one, and build one he did. This motor was so successful that immediately a market

Experiences in Building the Northrop Glider

By Charles A. Bushnell

My experiments in building a glider are typical of those of a large number of present-day glider fans. My brother, Fred, and I built a modified Chanute glider in 1921, and also a 22 ft. monoplane, before we finally found plans in *Modern Mechanics and Inventions* for a really good glider, the Northrop.

We began the construction of the glider in July, and found the job rather slow owing to the pains we had to take. We had quite a time when we applied the dope. There were three fellows helping us one Saturday night. I had used dope before and thought nothing much about it, but I noticed the fellows one at a time left for home and the next morning we had a big laugh. One thought he was getting sick and we had all pretended to be drunk — it didn't take much pretending either, as one of the fellows on the way home walked into a gas pump and did other foolish things.

It was decided that I was to be test pilot for the first flight, and we towed the glider down to the beach which was the scene of action. In order to get flying speed we had to have a car tow us and we also had to get a motorcyclist to hold up the wing tips. The first thing I knew I was in the air, only a foot or two off for about 200 ft. Then I climbed it, but they slowed the car. I put her into a glide but did not pull up in time, with the result that I hit pretty hard, breaking the seat, both wing tip skids, and pulling the landing wires loose.

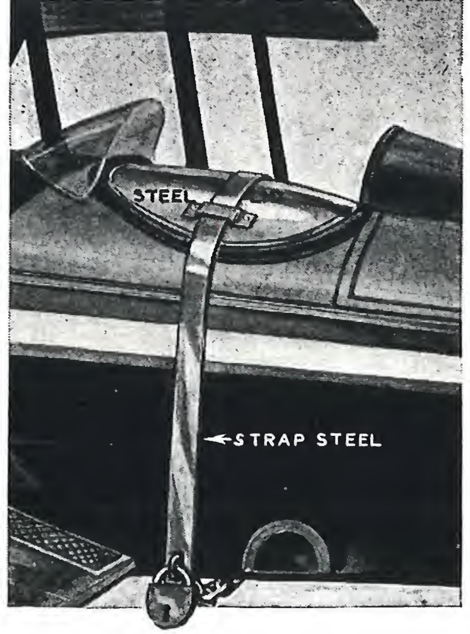
Repairs were made and the next Sunday we were ready again. At noon we towed my brother about a mile but could not get him off—not enough wind or speed, and in addition he's 40 lbs. heavier than myself. In the afternoon I tried it and took off almost at once, flew several hundred feet, and landed okay.

Since everything was all right, we decided to make the next tow a long one. Instead of letting me fly the ship up, however, they jerked me up to about 15 ft. and I had to signal the car driver to slow down, as the crosswind blew me off to the right side. Finally I got straight back behind the car and they jerked me up again. This was repeated about five or six times until the last, when they jerked me about 20 ft. high. I only had a 125 ft. tow rope, and an extra hard side wind struck me. I thought I was due to crack up, but managed to pull her back somehow. I landed pretty hard, however, loosening the landing wires and breaking the wing tip skids. I was in the air for 2,000 ft. or more, although I touched the ground twice. The glider was repaired without much difficulty. That's the advantage of a primary type ship — it resists the hardest kind of usage and is built so sturdily that the pilot is almost bound to come out of a crack-up safely.

Here are a few tips I've learned on glider flying: In taking off, the controls are held in neutral and it takes itself off. Care must be exercised to keep flying speed, and in landing it should be leveled off a foot or two above the ground and it will land itself. A beginner should only be allowed to make short and low hops. All students should be given an hour or so of practice on dummy controls until the correct movement is instinctive. *Never* fly without your safety belt being fastened, even on very short hops. •••

This photo shows the light weight of the completed glider.

Theft-Proof Cockpit Cover



A Chicago aviator who recently had a very valuable instrument panel stolen from his open cockpit airplane has installed the theft-proof cover pictured left to protect his instruments from further molestation.

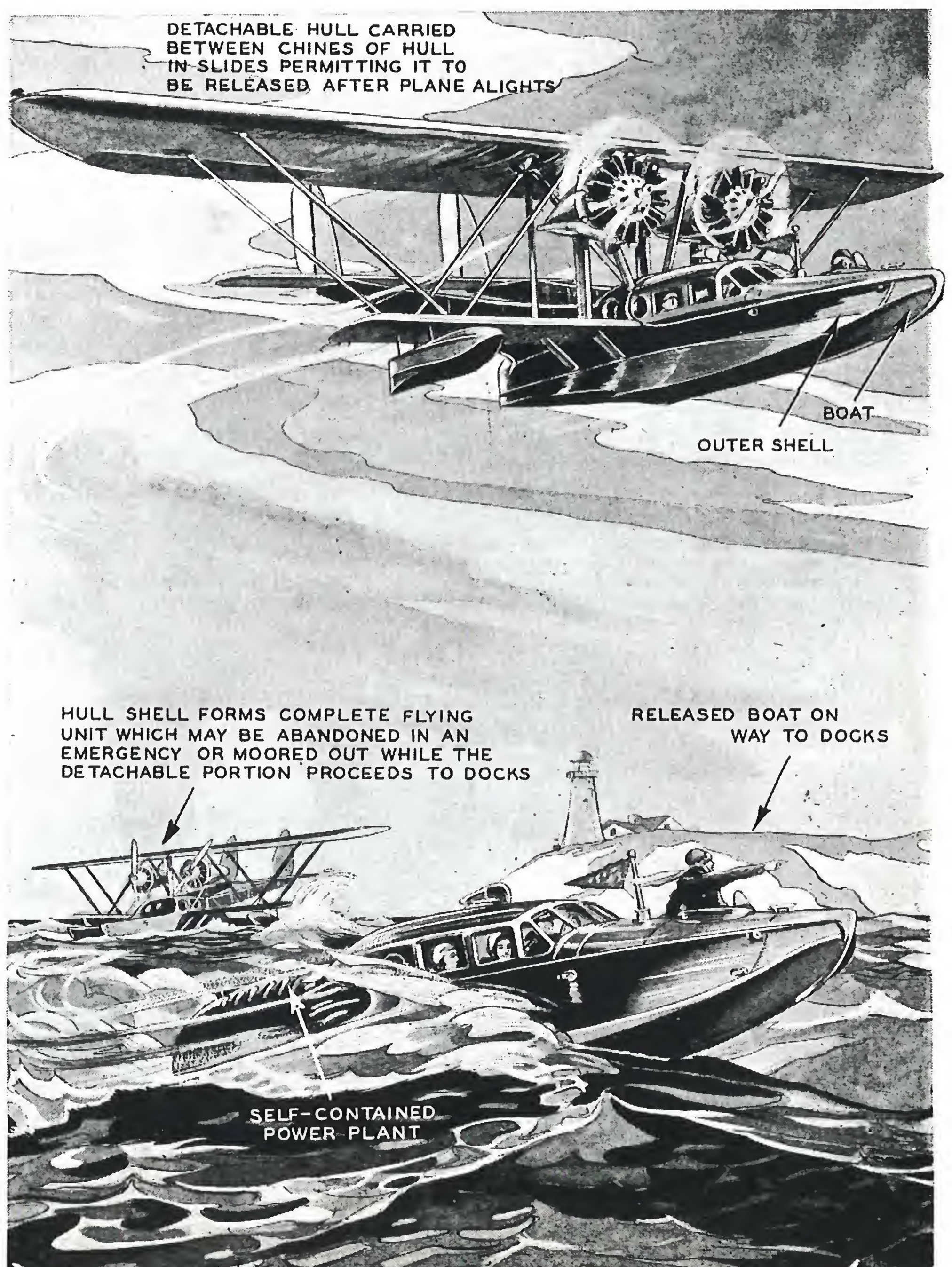
A lid of heavy sheet steel was made to fit down snugly into the cockpit opening. This lid was curved to match the fuselage fairing and a generous round metal beading was welded to the edges of the lid to protect the upholstered edge of the cockpit.

On top of the lid two pieces of strap steel were riveted, being bent so as to hold another long piece of strap steel which was bent so that it fitted the body of the fuselage like a saddle girth. A chain was attached to one end of the strap, while on the other end an eye was cut to fit the link on the other end of the chain.

To lock the cockpit, it is only necessary to fit the lid into place, pass the free end of the chain under the fuselage, and secure it with a strong padlock. It will be apparent that this device prevents the theft of the plane itself as well as the instruments.

Sea Plane and Motor Boat in One...

Flying boats of the future may be built so that they can shed their wings and motors and become motorboats. As shown in the drawing, the detachable pontoon forms the motorboat section of plane.



1931 -- The Beginning Of An Era -- The Golden Age Of Aviation!

The accomplishments aviation made during the thirties shaped our aviation of today — it supplied the aviation industry of World War II with the know-how, the men, the airplanes. It was an era of tinkerers, dreamers and do-ers! Many of our most talented men cut their teeth on the crates of World War I, the post war period, and the homebuilts of the thirties.

Today we feel we are in an extension of that period. True, we have a bit more know-how available, materials have improved, but we are still a long way from our goal of making the airplane available to more people — to add to its utility, safety and maintenance.

Where do we start? With people, of course!

EAA is people — and airplanes — and here in this 1931 FLYING MANUAL you will read about people. People who under many handicaps got into the air. Their story can serve as our inspiration of today.

We are pleased as an effort of the Experimental Aircraft Association Air Education Museum Foundation — and with the cooperation of Fawcett Publications — to put a little bit of our aviation past into today's living where it can serve as an inspiration to newer and greater accomplishments.

PAUL H. POBEREZNY, Pres.
EAA Air Museum Foundation

Introducing the 1931 Flying and Glider Manual

This is the third, or 1931, edition of the Flying and Glider Manual. *It carries on the aims and traditions of previous issues, which have been to present in compact form practical information on aviation for air-minded America.*

A glance at the chapter headings gives a good idea of the comprehensive field covered by this volume, and even a cursory examination of its pages indicates how crammed with meaty information its articles are. The purely theoretical has found no place in this Flying and Glider Manual. *The book has been designed to answer the questions which thousands of young men are asking, such as: "How can I get into aviation? How can I learn to fly? Where can I get plans for a reliable airplane, preferably one which I can build myself and which will not cost a fortune to fly? What kind of engines are available for lightplane use?"*

You'll find the answers to these questions in the pages that follow. There are five lightplanes presented for your approval; you can take the plans for any one of them and build an airworthy ship from them. There's the sturdy "Longster" and the speedy "Driggs Dart"; there's the racy "Church Mid-Wing Monoplane" and the "Georgias Special" — and there's the "Heath Seaplane Parasol and its Pontoons", a practical ship for northwoods country or any territory where lakes abound.

Many prospective airplane builders prefer to get practical experience in building and flying a glider before tackling the larger project of an airplane. For these, as well as for red-blooded young Americans eager to get into the swing of the great new sport of gliding, we present in these pages the plans for a secondary glider designed especially for this Manual. These plans are procurable nowhere else. And there are also a few tips on flying gliders by Ed Heath and others.

But why go on? You're eager to get busy on building that dream ship of yours, and we're just as eager to have you get going. Remember, the editors of the Flying and Glider Manual *stand ready to answer questions that may occur to you during the building process. Happy landings!*

•••

In action the Georgias Special is reminiscent of the new Boeing high-wing fighter. It flies strongly with the Lawrence, providing the motor is turning up properly, and the standard Lang prop is used.

Amazing in the daringness of conception, and expected to be far reaching in strategical value from a military standpoint is this remarkable new submarine-amphibian airplane secretly tested by Denmark.

Prepared by Paul Poberezny and S. H. "Wes" Schmid

Cover Drawing by Doug Rolfe . . . Drawing above by J. R. Zinno

EXPERIMENTAL AIRCRAFT ASSOCIATION

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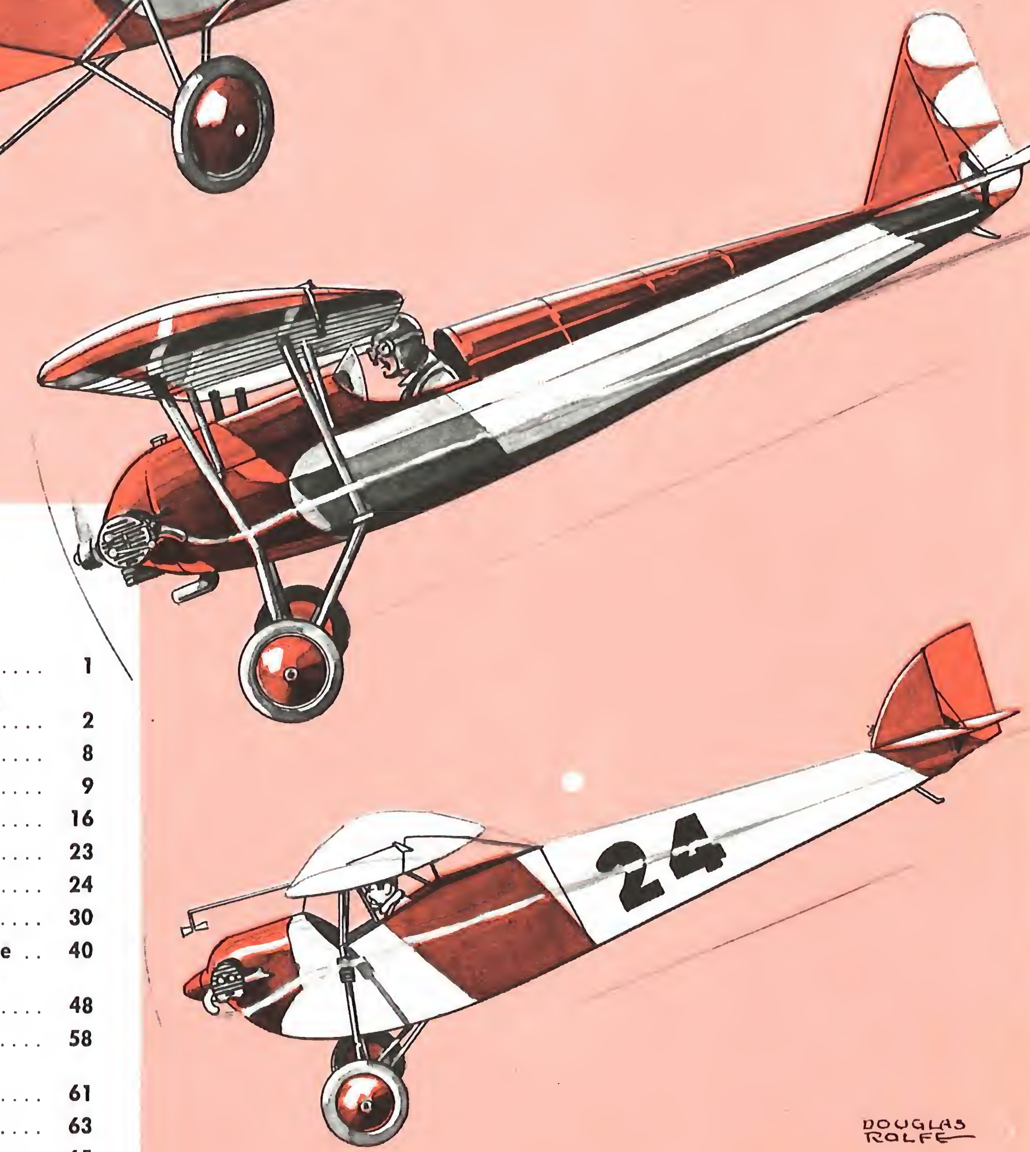
EXPERIMENTAL AIRCRAFT ASSOCIATION

FLYING and glider MANUAL



CONTENTS

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